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Economic and financial performance of the UK English Channel Fleet

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Summary

The English Channel fishery is a multispecies multigear fishery that can be considered to be an amalgam of numerous separate sub-fisheries. Commercial activity in the fishery is predominantly undertaken by fishers from the UK and France.

The purpose in this paper is to present the results of a cost and earnings survey carried out on the UK fishers in the English Channel. These results were used to assess the financial and economic performance of boats in the various component fisheries. Performance was examined in terms of both boat size and main fishing activity.

From the results, it was estimated that most operators covered their cash costs during the 1994-95 financial year. However, the level of cash profits varied significantly between boats depending on size class and main fishing activity. About 11 per cent of fishers interviewed were not covering their cash costs.

Most operators also covered their economic costs during the survey year. Economic costs include non-cash costs such as the opportunity cost of capital and labour, the returns that could be earned by these factors of production if they had been employed in the next best alternative activity. These non-cash costs are not included in a financial analysis but are explicitly included in an economic analysis. On average, economic profit in the fishery was negligible. Again, this varied significantly between boat size and main fishing activity. In total, around 29 per cent of the fleet were earning negative economic profits.

The fishery as a whole was not earning positive economic profits in 1994-95. From experiences in other fisheries around the world, fisheries are capable of earning substantial economic profits provided they are effectively managed. This implies that the English Channel fishery was not being managed to its full potential in 1994-95.

Fisheries management has many objectives, of which increasing economic performance is but one. Fisheries managers can manage their fisheries either directly through imposing restrictions or indirectly through offering incentives and thereby influencing the behaviour of fishers. Fishing behaviour is largely driven by economic incentives. While considerable attention has been paid to the assessment of the biological status of the fishery, little attention has been paid to the economic status of the fishery. This study is the first stage in addressing this imbalance. The assessment of economic performance is a key element in furthering the understanding of the economic incentives that exist in the fishery.

Introduction

The Channel fishery (ICES sub-regions VIId and VIIe) is a multispecies multigear fishery dominated by sole, plaice and high value shellfish species such as lobster and scallops. Commercial activity in the fishery is predominantly undertaken by fishers from the UK and France, although vessels from other EU countries (such as Belgium) and the Channel Islands are also active in the fishery. While the fishery is not large in terms of the total volume of catch, landings into the UK from the Channel fisheries represent about 40 per cent of the value of landings into England and Wales. In 1994, the value of landings in UK ports along the Channel was estimated to be about £103 million (see Appendix A), a large proportion of which would have been derived from the English Channel.

Despite the regional importance of the fishery, little is known about the economic and financial performance of the fishers themselves. Hence, management of the fishery has focused on the biological status of the resource. While biological sustainability is a necessary precondition for a sustainable fishery, the economic sustainability of the fishers is also of importance if the fishery is to persist.

An economic survey of UK fishers along the English Channel was conducted as part of a larger project to examine the bioeconomic interactions in the fishery. The aim of the project is to develop a model of the fishery encompassing the biological and economic interactions that occur in the UK component of the Channel fisheries. The survey, undertaken during late 1995 and over the first half of 1996, collected information on the costs and earnings of a variety of different fishing activities for the financial year 1994-95. Estimates of earnings and effort levels for the 1995 calendar year were also obtained.

The purpose in this report is to explain the methodology used in undertaking the survey and present the key findings.

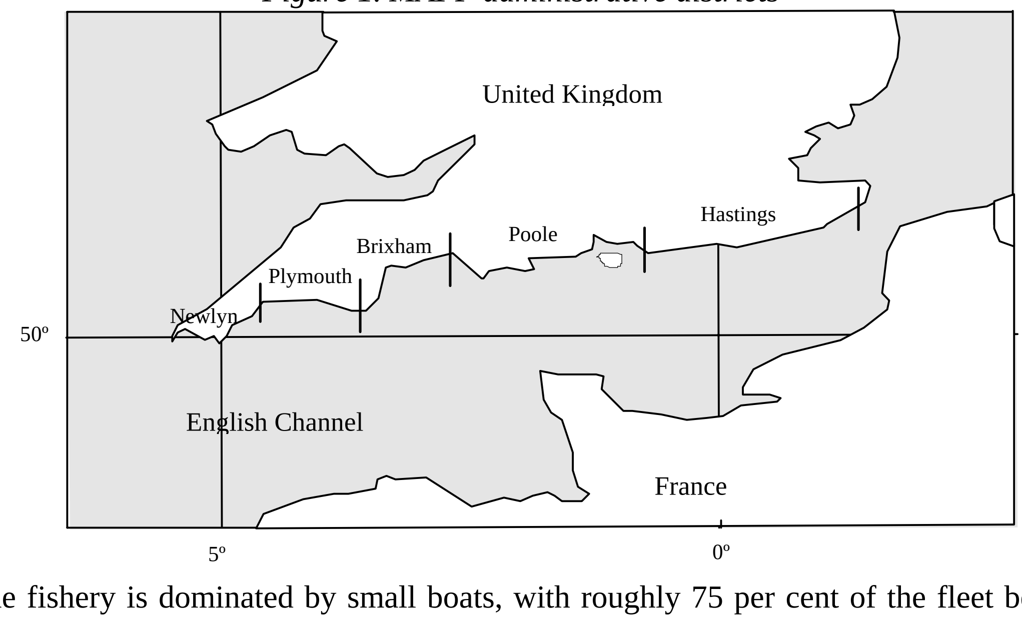
Background

In total some 4000 boats operate within the English Channel, over half of which are UK boats. About 90 per cent of these boats operated within 10 km of the coast (Tétard, Boon *et al* 1995), so interactions between the fleets of France and the UK are limited. While the stocks exploited in the UK inshore areas are generally not genetically different from those in the French half of the Channel, a strong current running west to east through the Channel is thought to reduce the amount of north-south mixing (Pawson 1995). As a result, many of the stocks exploited by English and French vessels can largely be considered as separate colonies for the purposes of management.

The UK side of the English Channel is subject to three levels of regulation administered by local Sea Fisheries Committees, the Ministry of Agriculture, Fisheries and Food (MAFF) and the European Union. These bodies have overlapping jurisdictions, although generally the Sea Fisheries Committees have responsibility for managing the first three miles, MAFF has responsibility for the management of boats up to the 12 mile limit and the EU has responsibility for managing waters beyond the 12 mile limit to the edge of the Exclusive Economic Zone. Restrictions imposed by the EU (such as catch quotas or minimum mesh sizes) are generally applicable to all waters. Similarly, MAFF restrictions imposed over the EU regulations form a minimum regulation within the 12 mile zone. Finally, the Sea Fisheries Committees can impose additional restrictions over and above those of MAFF and the EU within the six mile zone of their jurisdiction.

Five local administrative regions (defined by MAFF) exist along the UK coast of the English Channel (see Figure 1). By virtue of the fact that all boats must have a home port, all UK registered boats that operate in the English Channel can be nominally allocated to one of these regions (Table 1).

Figure 1. MAFF administrative districts



The fishery is dominated by small boats, with roughly 75 per cent of the fleet being under 10 metres in length (Table 1). In term of value of catch, however, the small boats are less significant than their numbers suggest (with the exception of Poole).

Less than 40 per cent of the value of the catch is taken by boats less than 10 metres overall length (Table 2). The bulk (60 per cent) of the value of catch was taken by boats between 10 and 30 metres overall length.

Table 1. Estimated distribution of the UK fleet by size and region, 1995

	Size class (metres)						
Region	Under 7	7-10	10-12	12-20	20-30	30+	Total
Newlyn	199	125	42	67	41	6	480
Brixham	112	64	25	37	30	10	278
Plymouth	62	114	50	17	4	0	247
Poole	356	353	85	11	2	2	809
Hastings	134	154	33	25	6	0	352
Total	863	810	235	157	83	18	2166

Derived from data supplied by MAFF

Table 2. Estimated value of landings by size class and region, 1994 (£ million)

	Size class (metres)						
Region	Under7	7-10	10-12	12-20	20-30	30+	Total
Newlyn	2.05	5.72	3.31	4.19	5.68	1.42	22.36
Brixham	0.02	5.72	2.06	8.32	14.61	0.12	30.86
Plymouth	0.07	5.44	5.32	3.60	1.44	0	15.87
Poole	1.62	12.25	3.96	0.08	0.93	0.53	19.37
Hastings	0.10	6.35	3.24	2.72	2.48	0	14.90
Total	3.86	35.47	17.89	18.92	25.14	2.07	103.36

Derived from data supplied by MAFF. Derivation of these figures is given in Appendix A.

The fishery consists of a wide range of fishing activities that are aimed at targeting a variety of species. For classification purposes, a number of sub-fisheries have been defined by reference to fishing technique, area fished, season and the subsequent composition of the catch. These sub-fisheries have been termed métiers (Tétard, Boon *et al* 1995).

To date, 72 separate métiers have been formally classified (Tétard, Boon *et al* 1995), of which 28 are attributable to UK boats. These métiers broadly fall into 7 gear types: beam trawl, otter trawl, pelagic/mid-water trawl, dredge, line, nets and pots.

Beam trawlers generally target sole, plaice and anglerfish, while otter trawlers generally target a variety of species including whiting, cuttlefish, plaice, sole and anglerfish. Dredges target shellfish such as scallops and oysters, but often also catch benthic fish species (for example, sole and plaice) as bycatch. Static gear, such as gill nets are employed to catch mainly cod which spawn in the eastern Channel, and hake, which are to be found mainly in the western Channel. Bass are targeted with nets as well as line.

Potting is the other main type of fishing activity in the Channel, predominantly undertaken by smaller boats in the inshore waters. The key target species are edible crab and lobster, although whelk potting is becoming increasingly important in the Eastern Channel. Much of the shellfish caught by both France and the UK is caught in the English Channel. In 1989, it was estimated that 87 per cent of all scallops and 96 per cent of all cuttlefish landed by French and English boats were caught in the Channel (Pawson 1995).

From the above, it can be seen that the Channel fisheries are diverse in terms of both type of fishing activity and range of species targeted. Any economic analysis of the fisheries needs to take this diversity into consideration.

Survey Methodology

While considerable attention has been paid to the biology of the English Channel, little information is currently available on the economic performance of the UK fishing fleet operating in the Channel. An economic survey of UK fishers along the English Channel was conducted to address this imbalance. The survey was undertaken during late 1995 and over the first half of 1996. The aim of the survey was to collect information on the fishing behaviour of the fleet as well as financial information (such as costs and earnings) for the 1994-95 financial year. In this section, the methodology underlying the survey is presented.

In order to develop a useful survey, it is necessary to determine the population to be targeted, the sample size to be collected, and a sampling strategy to collect the information. The target population is the set of units (usually people, objects, events, etc.) that are of interest. This may be a subset of the total population. For example, the target population may be limited to include only a particular part of the fishery. The total population is the complete set of boats, whereas the target population is the set of boats that meet the criteria for the subset.

In most cases, it is neither practical nor possible to collect information from the complete target population. A sample is selected from the target population, and inferences about the target population are drawn from that cross section from the relevant sample statistics (for example, the mean values and standard errors). Sample statistics are, in fact, random variables because different samples can lead to different values for the sample statistics. Given that the true values are always unknown (hence the need to collect data from a sample), the sample statistics are associated with a probability distribution that provide information on the probability that the estimates are true.

Target population and sample selection

A full list of all boats that operate in the English Channel irrespective of their home port was not available as fisheries managers do not collect information on all fishing activities. Because of this, it was necessary to use information on the port of registration in order to estimate the target population. The target population for the survey was taken to be all licensed fishing boats registered in ports between Folkestone and Newlyn in 1995. This was obtained from the MAFF Fisheries Statistics Unit, London. An assumption of the survey, then, was that all boats registered between these two ports operated in the Channel, and that boats from outside this range of ports did not operate in the Channel. This assumption is not necessarily realistic as there are bound to be boats on both sides of the border of the region that operate inside and outside the Channel.

The target population was stratified by size class and region as shown previously in Table 1. The purpose in stratifying the fleet was to ensure a balanced sample and thereby reduce sampling bias (see Appendix B). The regions reflect to an extent differences in fishing patterns. Most trawling activity takes place from the western ports, represented by Newlyn, Brixham and Plymouth, while netting and potting dominate the fishing activity in the central and eastern ports. The size classes used for stratification were suggested by various fisheries officers of the Sea Fisheries

Committees that have an input into management of the Channel fisheries. These officers were visited before the start of the survey to comment on the survey and questionnaire design.

Differentiation of the fleet in terms of boat size was thought important by the fisheries officers for a number of reasons. The size of the boat limits the activities in which it can participate. For example, small boats are generally limited to sheltered waters close to shore. These physical restrictions are likely to affect the relative economic performance of the boat groups. Boats under 10 metres overall length are also subject to different EU management regulations than boats over 10 metres in length. Different regulations (mostly at the Sea Fisheries Committee level) were also applied to boats under 12 metres in length than to boats over 12 metres in length. Boats less than 7 metres in length were generally thought to be operated by part-time fishers. These factors were also thought to affect the type of activity and economic performance of the fishers.

A stratified random sample (see Appendix B) of boats was selected for interview on the basis of both boat numbers in each size class/region category and the estimated value of landings. Selecting the sample only on the basis of boat numbers in each strata would have resulted in a larger sample of smaller boats. This would have been unrepresentative as these boats contribute less than proportionally to the value of landings in the fishery. For example, as mentioned previously, about 77 per cent of all boats in the fishery are under 10 metres, but these boats account for only 38 per cent of the estimated value of landings.

The weighting chosen for the sample distribution was 60 per cent estimated landings value and 40 per cent boat numbers in each stratum. It was assumed that a sample size of 100 boats would provide reasonably reliable results[1]. The sample was further modified to ensure that there was a minimum of three boats per stratum (in order to allow for the standard error of the mean to be estimated in each stratum). The final target sample distribution is given in Table 3.

Table 3. Target sample distribution by size class and region

	Size class (metres)						
Region	Under 7	7-10	10-12	12-20	20-30	30+	Total
Newlyn	5	6	3	3	5	0	22
Brixham	3	4	3	4	9	0	23
Plymouth	3	5	4	3	0	0	15
Poole	7	13	4	0	0	0	24
Hastings	3	7	3	3	0	0	16
Total	21	35	17	13	14	0	100

The target sample of boats selected for interview was further stratified by engine size. This was to ensure that the sample bias was minimised. The boats were sorted in order of increasing engine power in each size class/region strata. Every *n*th boat was selected for the sample, with *n* depending on the number of boats required from each stratum. For example, every 33rd boat was selected for interview from the Newlyn

[1] While it is possible to determine an optimal sample size, this requires information on the amount of variability in the fleet. An ex-post evaluation of the sample size indicated that the sample would have had to have been significantly larger to have greatly improved on the confidence in the results (see Appendix B).

under 7 metre stratum, whilst every 7th boat was selected for interview in the Newlyn 20-30 metre stratum.

The fishers selected for interview were sent a letter requesting their assistance, followed by a telephone call[2]. Where fishers could not be contacted (for example, out fishing when interviewing in the area) or were unable to participate in the survey, replacement boats were selected. The replacement boat selected was the next boat nearest to the target boat in the sorted list. As a result, the replacement boat was of similar engine power as well as being the same size class and from the same region as the boat originally selected. In some cases, recommendations were made to contact owners of alternative boat. Where these owners were willing to be interviewed, data were collected even if there were 'sufficient' numbers of responses in that group.

Despite considerable attempts to contact the selected fishers, the full target sample could not be achieved. Response rates in the regions varied. The number and distribution of fishers interviewed are given in Table 4. Financial and economic data for 11 boats collected in a previous CEMARE survey of Brixham fishers for the same period (Hatcher, Holland and Cunningham 1995) were used to supplement the Brixham data. These boats are also included in Table 4. Boats interviewed in the previous survey were not approached again in this survey.

A postal survey was also trialed on the Isle of Wight to see if the data could be collected in this fashion. As this group of fishers are within the Poole district, the potential lack of response from this postal survey was not an issue in terms of biasing the sample. A total of 50 fishers were sent a modified form of the questionnaire. These were in addition to the target sample indicated in Table 3. As is normally the case with postal surveys, response was poor, with only one survey form being completed and returned.

Table 4. Boats interviewed by size class and region

	Size class (metres)						
Region	Under 7	7-10	10-12	12-20	20-30	30+	Total
Newlyn	5	6	2	2	2		17
Brixham		5	8	1	8	2	24
Plymouth		5	2	1	1		9
Poole	2	9	5				16
Hastings	1	4	4	2			11
Total	8	29	21	6	11	2	77

Comparing tables 3 and 4 it can be seen that the final response fell short of the target. With most surveys, not all individuals approached will be willing to respond. Given the sensitive nature of some of the information requested, a degree of non-response was expected. Reasons for non-response are given in Tables 5 and 6. These include all fishers who were selected for interview (either as first choice boat or replacement boat) but who did not provide information. Tables 5 and 6 do not include non-response from the postal survey as these could not be classified.

[2] Boats whose owners were ex-directory were replaced by the nearest boat with an associated telephone listing. This may have some implications in terms of sampling bias if there was some difference between their activities and the replacement boat. These boat owners were not considered non-respondents as they were never contacted.

Table 5. Number of non-respondents and reason for non-response by size class

	Size Class (metres)						
Reason	Under 7	7-10	10-12	12-20	20-30	over 30	Total
Refused to participate	6	6	3	8	4	0	27
Still owned boat but not fishing	2	4	1	1	2	0	10
No longer owned boat	0	4	2	0	0	0	6
Not fishing much	2	1	0	0	0	0	3
Not fishing in the area	0	0	0	2	0	0	2
Could not arrange a time	1	0	1	2	2	0	6
Unobtainable	5	9	4	2	5	0	25
Ill health	1	2	1	1	0	0	5
"Another time"	2	2	2	2	0	0	8
Total non-response	*19*	*28*	*14*	*18*	*13*	*0*	*92*
Percentage of total 'contacts'	*70*	*49*	*40*	*75*	*54*	*0*	*54*

Table 6. Number of non-respondents and reason for non-response by region

	Region					
Reason	Brixham	Newlyn	Plymouth	Hastings	Poole	Total
Refused to participate	10	2	2	7	6	27
Still owned boat but not fishing	2	1	1	1	5	10
No longer owned boat	2	0	0	1	3	6
Not fishing much	0	0	0	0	3	3
Not fishing in the area	2	0	0	0	0	2
Couldn't arrange a time	4	1	0	0	1	6
Unobtainable	7	3	1	6	8	25
Ill health	1	1	2	0	1	5
"Another time"	3	1	2	2	0	8
Total non-response	*31*	*9*	*8*	*17*	*27*	*92*
Percentage of total 'contacts'	*56*	*35*	*53*	*61*	*63*	*54*

From these tables, it can be seen that non-response was fairly evenly distributed across each region, but varied considerably by size classes. Actual refusal only accounted for 29 per cent of the non-response in the survey. In most cases, the boat owner was not able to be contacted or a mutually convenient time could not be agreed upon for the interview. About 22 per cent of the non-response was due to the owner either no longer fishing or considering themselves not fishing enough to be of any interest[3].

The groups with the greatest non-response were the under 7 metre and the 12-20 metre boats. The high degree of non-response for these groups may have led to some bias in the results. This problem was overcome to some extent through appropriate weighting of the observations (see Appendix B). However, some bias in the results may still exist. For example, if the non-respondents were performing better on average than the respondents, then the bias in the results would be downwards. This would result in average profit levels appearing lower for the sample than the true population average. Conversely, if the non-respondents were performing worse than the respondents then the bias would be upwards. The direction of the bias, if any, cannot be determined without information on the non-respondents.

[3] Part time fishers were intended to be interviewed. However, this could not be impressed on some fishers, who thought they were being more helpful by not participating.

Questionnaire design

The questionnaire was designed in collaboration with Fisheries Officers from the Sea Fisheries Committees in each region, as well as officers from MAFF. Draft questionnaires were sent to a number of these officers for comment. The postal questionnaire was derived from the main questionnaire. This was intended to cover the bare minimum information required for the analysis. Copies of the questionnaires are available from the authors on request.

Information sought included costs and earnings data for the financial year 1994-95 and estimated for the calendar year 1995, effort information in terms of type and amount of gear used by season and species targeted. Fishers were also asked explicitly for details of their catches over the year. In addition, fishers were asked questions regarding their motivations to fish.

Results

The results of the survey can be separated into a number of areas: boat characteristics and fishing behaviour, financial performance and economic performance. The distinction between financial performance and economic performance is largely one of perspective. Financial performance is the measure of most interest to fishers, as it represents how much income they are left with at the end of the year. Economic performance is a measure which is of relevance to fisheries managers, as it indicates the relative performance of the fishery compared with other activities in the economy. Information from the survey can also be extrapolated to provide an indication of the economic value of the fishery as a whole.

Interpretation of results

The key results presented in the report are the mean values of the variables and their associated relative standard errors. The mean value is the weighted average of the group, taking into consideration the number of observations within each stratum, the position of the boat within the stratum and the number of boats in the population. The relative standard error (RSE) is an indicator of the degree of confidence in the sample estimate. This is the standard error of the estimate expressed as a percentage of the mean (see Appendix B).

As a general rule of thumb, there is a 95 per cent probability that the true population mean value is within 2 standard errors of the sample mean. This is not strictly true for small samples, as detailed in Appendix B. However, for simplicity the rule of thumb will be used in the subsequent discussion. Further details on relative standard errors are given in Appendix B.

Mean values and RSEs are not reported for groups with less than three observations. This is to both protect the confidentiality of participants as well as to ensure the statistical integrity of the results.

Boat characteristics and fishing behaviour

From the boat registration data provided by MAFF, it is possible to identify the average physical characteristics of the boats that fall within the target population. These can be compared with the average characteristics of the sample in order to examine the representativeness of the sample.

The average boat characteristics of the fleet as a whole are given in Table 7, while those of the sample are given in Table 8. As stated above, the relative standard errors (RSEs) in Table 8 are an indicator of the degree of confidence in the sample estimate. For example, there is a 95 per cent probability that the true population average length of under 7 metre boats is 5.7 metres ± 10.2 per cent (Table 8). As the actual length (from Table 6) of boats in this group falls within this range, the sample average is not statistically different than the population average.

From these two tables, it can be seen that the average lengths, vessel capacity units (VCUs)[4], gross registered tonnages (GRTs)[5] and the ages of the boats in the sample

[4] Vessel capacity units are measures of the fishing capacity of the boats defined for the purposes of fisheries management. The number of units held by a boat is defined as its length times its breadth plus 0.45 time it engine power (in kW). The total

were similar to those of the fleet as a whole. Engine power (in kW) was also generally similar. However, for the smallest group, the average engine power of the sample was significantly lower than the engine power of correspondingly sized boats in the fleet as a whole. While the average age of the 12-20 metre sample boats appears lower than the average age of the fleet, the two values were not significantly different. Information for boats greater than 30 metres overall length are not reported as there were insufficient observations to determine the level of variance, and hence the degree of confidence in the sample mean.

With the exception of the engine power of the smallest boat group, it can be seen that the sample was reasonably representative of the population, at least in terms of physical characteristics. From this it may be assumed that the sample was also fairly representative of the population in terms of fishing activity. While this was not necessarily the case, such an assumption was necessary if inferences are to be drawn from the sample to the population. Since the physical characteristics of the sample were similar to the population characteristics, such an assumption may be reasonable.

Table 7. Average characteristics of the UK Channel fleet by size class

	Under 7	7-10	10-12	12-20	20-30
Overall length (m)	5.5	8.5	11.1	15.0	24.8
Engine power (kW)	20.3	79.1	132.4	171.7	377.9
VCU	19.6	58.1	98.0	144.8	308.4
GRT	1.6	5.3	12.9	27.6	86.0
Age	16.7	19.1	16.7	26.6	29.1

Table 8. Average characteristics of the sample by size class

	Under 7		7-10		10-12		12-20		20-30	
	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Overall length (m)	5.7	5.1	8.0	2.1	11.0	1.3	14.6	4.3	25.4	2.4
Engine power (kW)	14.9	14.3	77.2	9.8	127.0	7.3	187.8	4.8	400.6	10.7
VCU	19.9	9.8	59.1	6.4	101.7	5.2	155.6	3.9	322.9	6.6
GRT	1.8	12.7	3.9	8.3	19.6	29.9	23.2	7.8	82.7	9.8
Age	14.4	35.3	19.2	12.2	17.7	17.5	18.9	25.6	28.5	11.7

From the information in Tables 7 and 8, it can be seen that the boats smaller than 12 metres in overall length were on average about 10 years younger than the larger boats. This trend was observed in both the sample and the population as a whole. Without a time series of data it is not possible to draw any inferences from this. It may be that smaller boats do not physically last as long as larger boats, or it may indicate that there has been an increase in the number of smaller boats relative to larger boats over the last two decades.

The boats were also classified on the basis of their main fishing activity. This was done on the basis of the gear type that was used for the greatest amount of time during the year. In total, eight main fishing methods were identified in the sample (Table 9). Some operators used different gear for similar lengths of time, and in some cases at

number of units in the fishery are limited. In order for a fisher to introduce a new larger boats into the fishery, they must purchase from other fishers sufficient units to meet the requirements of their new boat and allowing for appropriate aggregation and transfer penalties.

[5] Gross Registered Tonnage (GRT) is another measure of capacity of the boat, defined as the volume of the enclosed space aboard a boat. Two boats of the same physical size can have different GRTs depending on the amount of enclosed space on board.

the same time. Hence classification of boats into one gear type only may mask benefits associated with using more than one gear.

Average boat characteristics by main fishing activity are presented in Table 9. Comparative data for the fleet as a whole are not available as the fleet has not been classified in terms of fishing activity. In general, the smaller boats in the sample were found to use static gear (pots, nets, lines) whilst the larger boats tended to use mobile gear (trawls, dredges) (Table 9 and 10). About half of the under 10 metre boats used pots as the main fishing gear, targeting lobster and crabs. One boat in the under 7 metre boat group was found to dive for benthic species, aiming at landing high quality plate sized fish for the restaurant trade. While this represented 12 per cent of the sample of this size class, it is likely that the number of boats which participated in this activity were fairly limited.

Table 9. Average characteristics of the sample by main fishing activity

Main activity	Sample size	Overall length (m)		Engine power (kW)		VCU		GRT		Age (years)	
		Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Pots	23	7.7	4	64.0	16	52.0	12	4.4	21	14.4	17
Lines	5	6.5	16	33.5	49	31.9	39	3.1	44	36.2	32
Nets	13	8.6	10	69.3	27	61.4	23	6.8	36	15.3	17
Dive	1	na	na	na	na	na	na	na	na	na	na
Dredge	2	na	na	na	na	na	na	na	na	na	na
Otter trawl	19	9.8	5	118.1	9	89.4	8	13.1	40	21.6	14
Beam trawl	13	22.1	8	351.9	16	267.3	13	68.8	19	22.3	13
Pelagic trawl	1	na	na	na	na	na	na	na	na	na	na

na. Not available - average group results of groups with less than three observations are not reported.

Trawling was generally undertaken by boats over 10 metres (with a few exceptions). Boats under 20 metres tended mostly to use otter trawl gear, whilst boats over 20 metres tended to use beam trawls as the primary fishing gear (Table 10).

Table 10. Percentage of respondents using each gear type in each size class

	Size class (metres)					
Main gear type used	Under 7	7-10	10-12	12-20	20-30	30+
Pots	50	49	24			
Lines	25	10				
Nets	13	31	5	33		
Dive	12					
Dredge		3			9	
Otter trawl		7	67	50		
Beam trawl				17	91	100
Pelagic trawl			4			
Total	*100*	*100*	*100*	*100*	*100*	*100*

In total, 53 per cent of the boats surveyed only used one gear type. For the remainder of the sample, there was no clear pattern in terms of primary and secondary gear use (Table 11). The most diversified groups were the pot and net boats, with many pot boats also using nets and vice versa. With the odd exception, boats that predominantly used static gear as their main gear type also used other static gear as their secondary gear type. Similarly, users of mobile gear as their primary gear type generally used mobile gear as their secondary gear type. The exception to this were the otter trawl boats, which tended to use either static or mobile gear.

Table 11. Percentage of respondents using multiple gear types

Main gear type used	None	Secondary gear							*Total*
		Pots	Lines	Nets	Dredge	Otter trawl	Beam trawl	Pelagic trawl	
Pots	43	-	9	26	13	9			*100*
Lines	60		-	40					*100*
Nets	38	23	23	-		8		8	*100*
Dive		100							*100*
Dredge		50			-		50		*100*
Otter trawl	58		10	16	16	-			*100*
Beam trawl	92				8		-		*100*
Pelagic trawl						100		-	*100*

The number of days fished generally increased with the size of the boat (Table 12). The smaller boats tended to operate on a day trip basis whilst the larger boats' trips lasted several days. From many of the smallest boats (under 7 metres), trip length was relatively short as a number of operators also had other employment. The number of days fished in 1995 was estimated to be generally lower than in 1994 for all size classes (Table 12).

Table 12. Average annual effort and crew numbers by boat size

Size Class	Days fished 1994		Days fished 1995		Crew number	
	Mean	RSE	Mean	RSE	Mean	RSE
Under 7	172	11	171	11	1.1	57
7-10	169	8	165	9	0.9	16
10-12	193	7	188	7	1.3	14
12-20	201	11	181	11	2.4	29
20-30	254	4	250	4	4.0	8
30+	na	na	na	na	na	na

na. Not available - average group results of groups with less than three observations are not reported.

Crew numbers increased with boat size (Table 12). The largest crew number in the sample was 6 (excluding the skipper), found on a 20-30 metre boat. About one third of the sample employed no crew, with a further third of the sample employing only one crew member (Figure 2).

In terms of main gear type, net and otter trawl boats generally employed less effort (in terms of days fished) than the other gear types (Table 13). For net boats, the currents during the spring tides were too strong for the nets to be effective. Consequently they were limited to fishing only on the neap tides, effectively reducing their fishing time to half the year. Beam trawlers produced the most effort on average in terms of days fished (Table 13).

The line boats employed the least crew (Table 13). Even with a very high relative standard error, it can be said with confidence that the average number of crew employed was less than 1. Beam trawlers employed the most crew on average. This is as expected given that these boats were generally the largest boats in the fleet.

Table 13. Average annual effort and crew numbers by main gear type

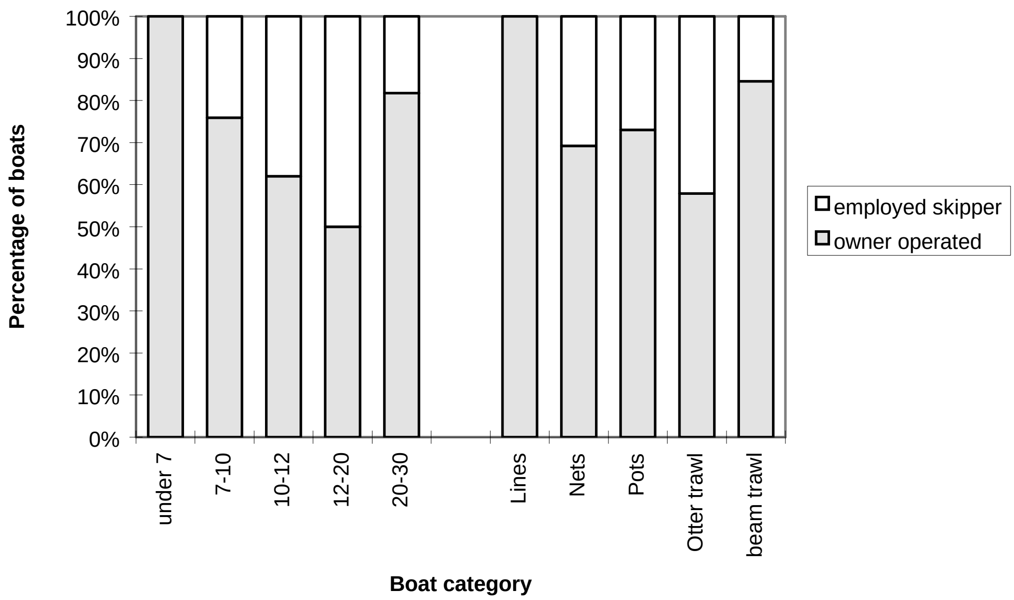
Main gear type	Days fished 1994		Days fished 1995		Crew number	
	Mean	RSE	Mean	RSE	Mean	RSE
Pots	204	6	204	6	0.8	23
Lines	170	28	163	30	0.2	119
Nets	151	8	145	9	0.8	49
Dive	na	na	na	na	na	na
Dredge	na	na	na	na	na	na
Otter trawl	149	12	145	12	1.2	14
Beam trawl	256	3	246	10	3.3	12
Pelagic trawl	na	na	na	na	na	na

na. Not available - average group results of groups with less than three observations are not reported.

Figure 2. Frequency of number of crew employed (excluding skipper)

Most of the boats interviewed were owner-operated, although a number of boats employed a skipper (Figure 3). While the proportion of boats employing a skipper tended to increase with boat size, this trend was not maintained by the largest boat size class. Consequently, no clear relationship can be determined between boat size and the propensity to employ a skipper. Similarly, no relationship between gear type and propensity to employ a skipper was observed (Figure 3).

Figure 3. Percentage of boats employing a skipper



Information on the type of licence held was also collected during the survey. All operators had a category A licence issued by MAFF. For under 10 metre boats, this enabled them to fish for either quota or non-quota species. For boats over 10 metres in length, the licence had to be endorsed in order for fishers to land quota species (pressure stocks). A breakdown of the category A licences are given in Table 14. From this table, it can be seen that the majority of boats over 10 metres held pressure stock licences. However, a small number of over 10 metre boats held non-pressure stock licences (about 18 per cent of the over 10 metre boats interviewed).

Table 14. Percentage of boats holding licence type by size class

Size class (metres)	Under 10 metres	Non-pressure stocks	Pressure stocks
Under 7	100		
7-10	100		
10-12		33	67
12-20			100
20-30		33	67
over 30			100

In addition to the category A licence, the Cornwall Sea Fisheries Committee (covering the Newlyn administrative region) imposed additional licence requirements on shellfish fishers operating within the waters under their jurisdiction. As a condition of these licences, fishers had to provide the Sea Fisheries Committee details of their catches.

Financial and economic performance by boat size

Key financial indicators are the level of revenue, running costs, crew costs, fixed costs and boat income. Revenue is the value of the catch landed[6]. Running costs are the short term variable costs, including fuel, ice, bait, food and marketing levies. Crew

[6] In some cases, the fishers also used their boats for fishing charters. The income derived from this was also included in the boat revenue. This was relatively uncommon and did not form the main part of the fishing income.

costs are the payments to employed crew (excluding skipper), generally derived as a share of net revenue (revenue less running costs). Fixed costs are the short run fixed costs. These are costs that do not vary with the level of fishing activity by an individual boat, such as administration and insurance costs[7]. However, these costs may vary between different sizes of boats. Boat income is a financial profit measure derived by subtracting the total cash costs from revenue.

The distinguishing feature of an economic indicator is that it includes all costs that are generated by the activity of a particular size class or gear type. In this sense an economic indicator indicates the real resource cost of the activity. This distinguishes it from a financial indicator since it now includes the opportunity cost of labour and capital. That is, what would have been earned by undertaking the next best alternative activity and/or investment. If these returns are not being earned, fishers would be better off in the alternative activity or investment.

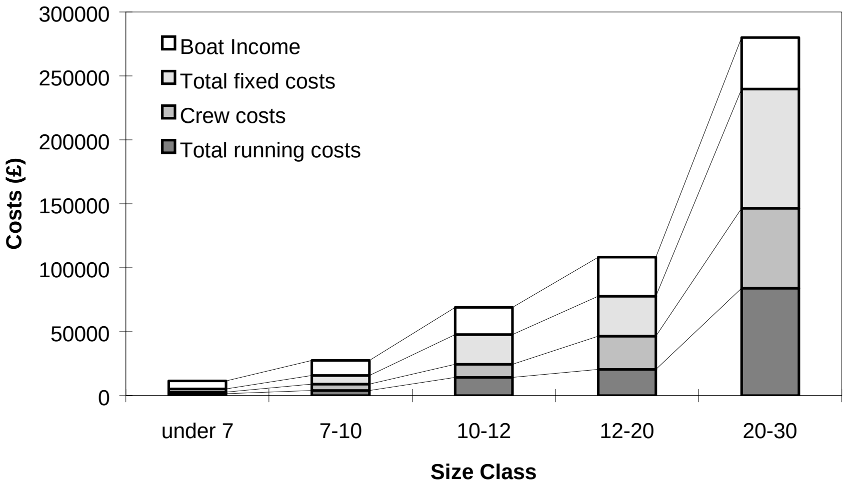
Financial performance indicators

The financial breakdown of the sample by size of the vessel is given in Table 15 and summarised in Figure 4. As previously indicated, information on boats over 30 metres in length has not been included in Table 15 due to the small sample size.

Revenue

As would be expected, average revenue increases with boat size, approximately doubling with each increase in size class.

Figure 4. Costs and income over size category.



[7] There is a further category of costs that do not neatly fall into either fixed or variable costs. For example, boat repairs may vary with the level of activity but regular maintenance is necessary irrespective of fishing activity. Similarly, gear costs may increase with activity, but gear can be lost at any time requiring replacement. Harbour dues for some boats may be related to the level of their activity. For the purposes of this analysis, these costs are assumed to be fixed.

Table 15. Financial performance indicators by size class (£, average per boat, 1994-95)

	Under 7		7-10		10-12		12-20		20-30	
	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Revenue	11505	19	27515	11	68996	15	108352	23	280096	12
Running costs										
• Fuel and oil	545	32	1290	13	5908	14	7630	22	52578	14
• Ice	22	112	40	90	625	37	1265	20	3275	12
• Food	7	146	55	53	1476	35	2959	28	8266	14
• Bait	539	58	2221	26	3744	48	0	0	0	0
• Levies	399	52	406	35	2385	20	8626	25	19791	17
Total running costs	1512	29	4012	15	14138	16	20481	22	83911	13
Crew costs	1215	59	5052	21	10283	14	26110	30	62664	16
Fixed costs										
• Repairs and Maintenance	1339	32	3724	16	14811	19	15569	16	49157	20
• Harbour dues	382	57	323	22	739	26	2105	45	3320	45
• Insurance	253	30	632	14	2215	12	4870	12	17297	14
• Administration	286	81	429	15	1274	14	1557	6	4156	24
• Survey costs	0	0		0	23	89	1020	31	5911	45
• Equipment hire	0	0	118	44	554	22	1022	54	2551	32
• Other rental	26	61	67	56	41	106	0	0	102	62
• Interest	10	146	449	34	2070	42	4521	84	8219	61
• Other costs	233	53	971	26	1534	20	419	38	2365	36
Total fixed costs	2529	30	6715	15	23260	14	31082	13	93079	14
Boat Income	6248	19	11736	15	21315	26	30679	47	40442	31

Running Costs.

Running costs comprised between 25 and 35 per cent of the total costs (Table 16). These costs vary with the level of activity. Fuel, food and ice costs are affected by the number of days fished, while levies are affected by the value of the landed catch (revenue).

Table 16. Percentage of total costs

	Size class (metres)				
	Under 7	7-10	10-12	12-20	20-30
Total running costs	28.8	25.4	29.7	25.9	35.0
Crew costs	23.1	32	21.6	33	26.1
Total fixed costs	48.1	42.6	48.7	41.1	38.9

Fuel and oil costs represented a relatively constant proportion of running costs for boats under 20 metres in length at about 10 per cent of total costs. This more than doubled for the 20-30 metre boat category because of the differences in main fishing method. As previously stated, the larger boats in the sample tended to use mobile gear whereas the smaller boats tended to use static gear. Boats using mobile gear had a significantly larger consumption of fuel as they were restricted to operating further from the shore (due to Sea Fisheries Committee management restrictions) and fished by dragging heavy gear. These larger boats also fished more than the smaller boats, which would explain the overall increase in fuel and oil costs relative to the fixed costs.

Ice costs are predictably lower for the smaller boats, representing less than one percent of total costs. Smaller boats had shorter trips and were therefore less likely to need ice to preserve their catch. In contrast, larger boats tended to have trips lasting several days, requiring more ice to keep their catch fresh. Larger boats had higher food bills for a similar reason, their trips were longer and they tended to have more crew.

Larger boats had zero bait costs because of the fishing method they employed. The smaller boats in the sample tended to be line and potting boats, thereby requiring bait. The larger boats tended to be trawlers or net boats and therefore did not require bait.

Levies (which include market levies, agent fees and Producer Organisation (PO) levies) were determined as a percentage of the value of the landed catch. Generally, the levies for the small boats were lower as a proportion of revenue than the larger boats. Levies for the under 7 metre boats averaged 3.5 per cent of revenue, whereas levies for 20-30 metre boats averaged about 7 per cent of revenue. Boats in the 7-10 metre category tended to have considerably lower levies, representing only 1.5 per cent of revenue. There are several explanations for this. The smaller boats tended to sell through agents (who generally do not charge the fisher a commission or levy), whereas the larger boats sold their catch through auction markets that charged a levy. Also, many of the larger boats interviewed were members of a PO, which in general charge an additional levy on catch.

Crew costs

Information on payments to skipper and crew were collected separately in the survey. Crew costs were the actual payments to crew. While a number of boats had employed skippers, the majority of boats were owner-operated (see Figure 3). To enable a comparison to be made across all boats, costs have been estimated on the basis of owner-operator equivalent costs. That is, the costs of skippers (where employed) have been excluded from the financial analysis. Hence the returns to the skipper (whether owner operator or employed) are included in the financial profit measure.

Crew are generally paid a proportion of net revenue, determined by deducting running costs from revenue, although a small number of crew were paid a proportion of gross revenue. Both the total crew payment and the average payment per crew member increased with boat size (Table 17). The higher annual payment for the crew members on the larger boats reflected the greater number of days fished. On a per day basis, there was not a large difference in payment per crew member for the larger boat size classes. The low average payment per day for the smallest size classes was largely a function of the part time nature of this size class. While small boats on average employed one crew member, they were not taken out every trip. Also, the smaller boats fished for a shorter period per day than the larger boats.

Table 17. Mean payment per crew member

Size class	Crew share	Mean number of crew	Mean payment per crew member	Mean payment per day fished
Under 7	1215	1.1	1104	6
7-10	5025	0.9	5583	33
10-12	10283	1.3	7910	50
12-20	26110	2.4	10879	54
20-30	62664	4.0	15666	62

Fixed Costs

Fixed costs are those costs that do not vary within a year with the level of fishing activity of the individual boat, but may vary across boat sizes. Generally, between 40 and 50 per cent of all costs were fixed in the short term across all size classes (Table 16). The major fixed cost item was the cost of repairs and maintenance. For large boats, interest payments and insurance costs were also significant.

Repairs and maintenance include repair of both boat and gear as well as gear replacement. While the amount of repairs may be affected by the level of effort, there is no direct relationship. Boats and gear can be damaged at any time in any trip, and boats that are not used still require ongoing maintenance. For most of the boats, the bulk of this expenditure was on the boat itself, though for some boats gear repairs and replacements were substantial. Total repairs and maintenance was larger for the big boats, with a large increase in costs from the 12-20 metre class to the 20-30 metre class. This was partly due to the fact that bigger boats have more to repair and also tended to be otter and beam trawlers. These boats require regular maintenance since the productivity of the gear is determined by the amount of ground covered by the vessel. Mobile gear is also more susceptible to damage than static gear, as inadvertently trawling over rough ground will ruin the gear. In contrast, static gear is less likely to get damaged during its use, but does wear out over time due to the corrosive effects of sea water.

Harbour dues increased with boat size for boats over 10 metres in length. Boats over 10 metres were subject to a per metre charge in most harbours, whereas boats under 10 metres generally paid a flat rate. Also, many of the smaller boats may have been removed from the water when not in use, which would bring down the mean level of harbour dues for this group.

Many of the smaller boats (particularly wooden boats) did not have insurance as the cost of the insurance was high relative to the capital value of the boat. As a result, average insurance costs for these boats were low. Boats under 10 metres were not required to meet regulations set by the DTI survey, therefore did not have survey costs.

Administration costs include accountancy, telephone and bank charges. These increased for over 10 metre boats. Many of the smaller boats could organise their own financial arrangements and tax returns, resulting in relatively low administrative costs. In contrast, larger boats generally had more complex fishing operations and so required more sophisticated accounting techniques. Larger boats were also more likely to require a greater quantity of financial services, resulting in higher bank charges over the year.

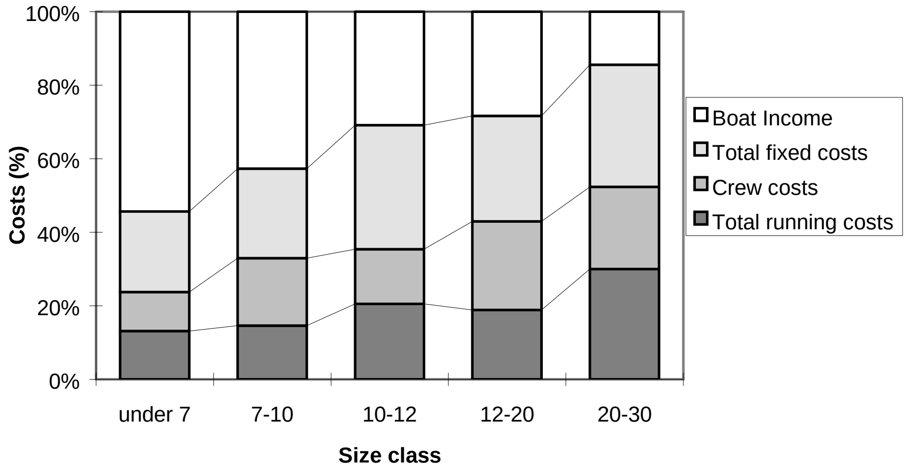
Equipment hire increased with the size of boat. Larger boats generally fished further out to sea and therefore required more sophisticated navigation and search equipment. The larger boats were also required to have more safety equipment to meet the DTI survey standard, some of which was rented.

Boat Income

Boat income is a financial profit measure derived by deducting running, crew and fixed costs from gross revenue. It is essentially the return to the owner of the boat, and includes a return to their own labour as well as a return on their investment.

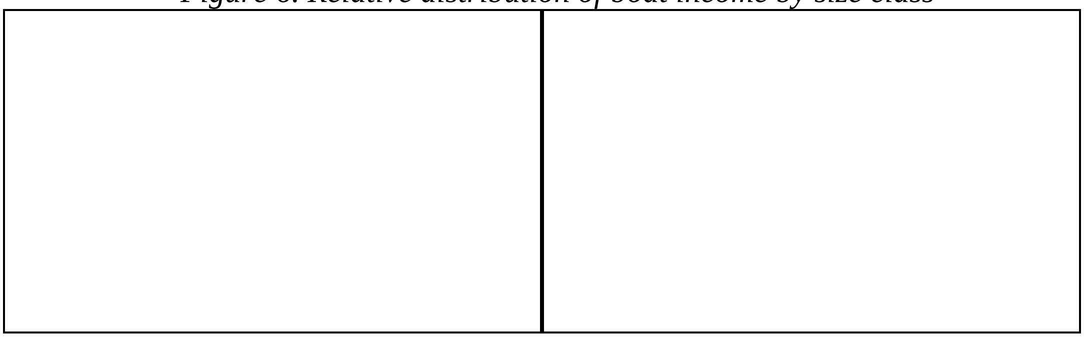
From Table 15, it can be seen that on average boat income was positive in each size class, and increased with increasing boat size. While both revenue and costs increased exponentially, boat income increased by about £10,000 between each size class (with the exception of the smallest size class). However, boat income fell as a proportion of revenue as the size of the boat increased (Figure 5). For the smallest size class, boat income was about 54 per cent of the total revenue, whereas for the 20-30 metre group boat income was only about 14 per cent of the total revenue. In absolute terms, the boat income for under 10 metre boats was relatively low, but this would more than likely not have been their only source of income.

Figure 5. Costs and income as a proportion of total revenue.



While boat income on average was positive for all size classes, not all boats interviewed in the survey were covering their costs over the period in question, as illustrated in Figure 6[8]. Some boats were making substantial losses, as shown in the 12-20 metre and the 20-30 metre classes. In total, 11 per cent of the boats interviewed did not cover their cash costs in 1994-95.

Figure 6. Relative distribution of boat income by size class



[8] A scale on the left hand axis has not been provided since the relative distribution within a group is more important than between groups. With a sufficiently large sample the distribution would be approximately normal with 95 per cent of observations falling within 2 standard errors of the mean. With a small sample, this is less apparent.

Economic performance indicators

The distinguishing feature of an economic indicator is that it includes all costs that are generated by the activity of a particular size class or gear type, exclusive of all redistributive payments such as interest or hire charges. In this sense economic indicators take into consideration the real resource costs of the activity. This is distinct from financial indicators that measure the viability solely in terms of commercial profitability.

Unless markets are perfect, economic costs and benefits differ from financial costs and benefits. Economic benefits from fishing include society's value of the product of fishing (the value of the catch) plus the value derived from the existence of the activity. In this study, economic benefits are assumed to be equal to financial revenue. An implicit assumption underlying this is that society holds no intrinsic value for the activity of commercial fishing. Whilst there may be an intrinsic value associated with fishing there is no information available to enable it to be incorporated into the analysis. By assuming that society's value of the catch is equal to financial revenue, it is also assumed that the markets through which fishers sell their catch are competitive and efficient. This is a reasonable assumption given much of the catch passes through auction markets.

A number of simplifying assumptions have also been made with respect to economic costs. Economic costs for of the crew, running costs and most fixed cost items were assumed equivalent to financial costs. This is not an unreasonable assumption to make given that markets for these inputs are well established and competitive. For crew costs, this assumption is equivalent to suggesting that crew could always gain employment on an alternative boat operating in the fishery.

It has also been assumed that the overall level of catch is sustainable at current levels. Therefore there are no economic costs associated with stock depletion arising from over-exploitation. If the level of catch is actually resulting in the depletion of the resource, then there is an additional economic cost in terms of forgone future production. Conversely, if the level of catch is allowing the stocks to rebuild, then there are additional benefits in terms of increased future production that would need to be valued to determine the overall economic performance of the fishery. Again there is insufficient information available on which to make an assessment of the forgone revenue from current catch levels.

The key economic performance indicators are given in Table 18 and summarised in Figure 7. Revenue and running costs are as previously defined. Fixed economic costs and labour costs have increased as they now include all resource costs (see below). Consequently, the economic return to each size class, reported here as full equity profit, are generally less than that recorded by the financial indicator, boat income. The general trend across increasing size class, however, remains positive and increasing.

Table 18. Economic performance indicators by size class (£, average per boat, 1994-95)

	Under 7		7-10		10-12		12-20		20-30	
	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Revenue[a]	11505	19	27515	11	68996	15	108352	23	280096	12
Total running costs[a]	1512	29	4012	15	14138	16	20481	22	83911	13
Labour costs										
• Crew[a]	1215	59	5052	21	10283	14	26110	30	62664	16
• Skipper	3408	19	8122	11	14970	15	19950	25	24159	12
Total labour costs	4623	27	13174	14	25253	14	46060	27	86823	14
Fixed economic costs										
Total fixed costs[a]	2529	30	6715	15	23260	14	31082	13	93079	14
• Less interest and rental costs[a]	36	56	635	32	2666	31	5542	77	10873	51
• Plus depreciation	154	12	385	10	1303	20	2818	15	7174	20
Total fixed economic costs	2647	30	6465	14	21897	15	28358	13	89380	12
Full equity profit	2722	28	3863	33	7707	39	13453	43	19981	63
Capital value	7020	12	17517	10	59245	20	128092	15	326108	20
Rate of return (%)[b]	39		22		13		11		6	

notes: a) From Table 16. b) Estimated by dividing full equity profit by capital value. No relative standard error was estimated.

Figure 7. Economic performance indicators

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Imputed skipper costs

In the assessment of financial performance, only crew payments were considered as labour costs. In an economic analysis, skipper costs are included along with crew costs in labours costs as they are a resource cost incurred if the boat operates in the fishery.

In a number of cases skippers were paid employees and were therefore distinct from owner operators (see Figure 3). In determining economic costs it was therefore necessary to impute a value for skipper share for the boats that did not employ a skipper. The intuitive reasoning applied here is that the owner-operator’s labour does have a value that does not receive an explicit return in a financial analysis. Instead, the payment for their labour is bound up with boat income. To reveal true economic costs and returns the skipper share therefore needed to be separated from boat income.

The basis for the imputed value for skipper share is the opportunity cost. That is, what the owner-operators could have earned had they worked in the next best alternative employment. In this case, it was assumed that the next best alternative employment for owner-operators was to skipper somebody else's boat. Thus, the opportunity cost of their labour is equivalent to what it would have cost the operators had they employed a skipper rather than skipper the boat themselves. This value was calculated as a proportion of boat income based on the observed relationship between net revenue and skipper share reported where a skipper was employed. In total, 20 of the boats surveyed (26 per cent) employed a skipper. Skippers were employed on boats in most size classes (with the exception of the under 7 metre boats), although predominantly on the larger boats. The estimated skipper share of net revenue used in the estimation of the imputed value of skipper labour are given in Table 19.

As would be expected, the skipper share on the smaller boats was substantially higher as a percentage of net revenue than the larger boats. This is because with the smaller boats labour was a more significant factor in production. Also, net revenues were relatively low in the smaller boats so a lesser percentage would not have attracted skippers to these boats, particularly as higher absolute incomes (even though smaller percentage shares) could have been earned on the larger boats.

Table 19. Skipper share of net revenue

Size class	Skipper share of net revenue (%)
under 7[a]	34.12
7-10	34.12
10-12	27.04
12-20	23.03
20-30	12.25
30+ [b]	12.25

a) Based on observed skipper shares in the 7-10 metre size class b) Based on observed skipper share in the 20-30 metre size class.

While the absolute value of the skipper share for the small boats in Table 18 were relatively low, they were reasonable given that they did not put as much time into fishing as skippers on larger boats. For example, assuming that skippers on the smallest size class boats worked on average 4 hours a day, then the imputed skipper income works out at about £5.00/hour (Table 20). In contrast, assuming that skippers on 20-30 metre boats worked on average 12 hours a day, then this equates to about £7.50/hour. Given the higher level of responsibility undertaken by skippers of larger boats these figures appear reasonable.

Table 20: Estimated comparative skipper income across class size

	Under 7 metres	20-30 metres
skipper share	£3408	£24159
average number of days fished p.a.	170	270
skipper share per day	£20	£89
skipper share per hour	£5.00	£7.50
(assumption)	(4 hour day)	(12 hour day)

A degree of caution should be maintained with any imputed value, particularly where other key variables are sensitive to the value. In this case, however, significant confidence can be placed in the imputed skipper values as they were based on observed skipper payments in the fishery.

Fixed economic costs

Fixed economic costs include most of the components in total fixed costs as outlined above in the analysis of the financial performance. However, interest payments and rental charges are not included as they are pecuniary payments for the use of physical capital[9] and therefore not a real resource cost. From the perspective of the overall economy these are simply redistributive payments from one sector of the economy to another. In this sense there is no real resource cost associated with this exchange since, from society's point of view, all resources are owned by somebody.

From the fishers perspective the position is slightly different. For them the payment is a cash cost since they do not fully own the assets and therefore the interest payment reduces their income. As different fishers have different levels of equity, including interest payments in the analysis would distort the measure of relative profits since this could be a function of either the level of equity or the economic performance of the boat. If fishers fully owned their assets (that is, had full equity or thereby no debt), the interest payment would effectively be to them and therefore included in their profit measure. In contrast, an operator with low equity would have a high interest cost and hence a low profit level even if they are operating relatively efficiently. The use of a full equity equivalent measure, then, has the advantage that the relative economic performance of the boats can be compared irrespective of the level of equity held by the owner[10].

Fixed economic costs also include the full economic cost of capital. The economic cost of capital employed by the fishing operator has two components. The first is the economic consumption of the capital asset or economic deprecation. The second is the opportunity cost of capital (Friedman 1986).

Wear and tear of an asset over the year will cause the selling price of an asset to fall, other things being equal. This is commonly referred to as deprecation. Maintenance is generally undertaken in order to offset this decline, and from a purely financial perspective maintenance costs are therefore the only relevant cost. From an economic perspective, if maintenance does not completely offset the decline in the value of the asset the full resource cost of the activity is unrecorded. An adjustment therefore has to be made. Theoretically it is the true economic depreciation of the asset that should be calculated. That is, the measure of actual loss in value that is not offset by maintenance costs over the period thus resulting in a decline of the asset's value. This is different from the accountancy calculation of depreciation which is based on a proportional allocation of the historic cost of the asset in each year of the asset's life. In practice the distinction between accountancy deprecation and economic deprecation is often blurred since the former is often taken as the basis for a proxy calculation of the latter. In this study, the true economic rate of depreciation was estimated rather than using an accountancy based measure.

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[9] In a fishery, there are two forms of capital employed. Physical capital is the capital used in harvesting the resource. Biological capital is the stock which is harvested. The biological capital is generally considered as the property of society as a whole. As such, there are arguments for extracting a return to society for the use of this asset. An allowance for a community return is not included in this analysis.

[10] As well as the practical reasons for excluding interest payments in economic analysis, there is also the economic reason that interest payments are pecuniary payments. That is, they are a transfer within society rather than a true resource cost.

The depreciation rate was estimated by comparing the purchase price of the boat (inflated to the 1994 value using the wholesale manufactured products price index (CSO 1996 and earlier issues) with the estimated current value of the boat (estimated as the insured value). From this, it was estimated that the real depreciation rate (after maintenance) was 2.2 per cent a year (relative standard error of 36 per cent). While this rate appears low compared with recognised depreciation rates in other industries, much of the depreciation in capital value is offset by regular maintenance of the boats. These maintenance costs are already incorporated into the financial and economic analysis. Similarly low depreciation rates have also been observed in other European fisheries (Davidse *et al* 1993).

The real depreciation rate was also examined by size class. While there was an apparent decline in depreciation rate with increasing size, the rates were not significantly different. Consequently a common rate was applied across all size classes. To ensure that deprecation was not double counted capital values were adjusted. Capital values collected in the survey were assumed to relate to 1995, and hence were end of financial year values. These were adjusted using the depreciation rate to derive the starting physical capital value for the period.

The opportunity cost of capital is the expected return forgone by holding the capital asset rather than some other comparable asset. This can be expressed as either a rate of return or as an absolute value. In this study, the opportunity cost of capital is taken as the normal or expected rate of return, against which the estimated rate of return to capital can be compared (see below). Consequently, the measure of economic fixed costs in Table 18, while including a measure of economic depreciation, does not include a measure of the opportunity cost of capital.

The expected return is simply the benchmark for determining the economic performance of capital employed. For example, if rates of return for the activity are less than the expected rate of return there is a negative economic return to society of employing capital in the current activity. The objective benchmark for determining the opportunity cost of capital is the rate of return of firms in other industries with similar levels of risk. However, given that the Channel fishery contain a diversity of boat types undertaking different fishing activities it is difficult to identify an appropriate expected rate of return.

A number of observed rates of returns for different industries in 1994-95 are given in Table 21. Using the rate of return in agriculture as a proxy for expected return is unsatisfactory because there is comparatively less risk involved. Higher rates of return have been calculated for some fisheries. For example, in the Irish Sea the fishers' discount rate was estimated to be 25 per cent (Hillis and Whelan 1994). In contrast, a rate of return based on information from the subsidiary fishing agency and trading section of Linton Parks PLC (previously Associated Fisheries PLC) was estimated to be around 10 per cent. This latter value was considered the most intuitively appealing as an approximation of the expected return. First, fishing activities of the company were predominantly UK based. Second, it reflected to a degree the special characteristics of the sector as it was based on a company of equivalent risk. Third, as it is listed on the stock market, it is expected that the company is operating as a profit maximiser and would attempt to invest in those fisheries giving the greatest return for the level of risk.

Table 21. Rates of return to capital (%), 1994-95

Base lending rate [a]	5.5
Rate used for analysis of public investment [b]	6.0
Agriculture (All farms, England only) [c]	4.2
Linton Parks PLC (Subsidiary fishing agency and trading section) [d]	9.9
Irish Sea fishery [e]	25.0

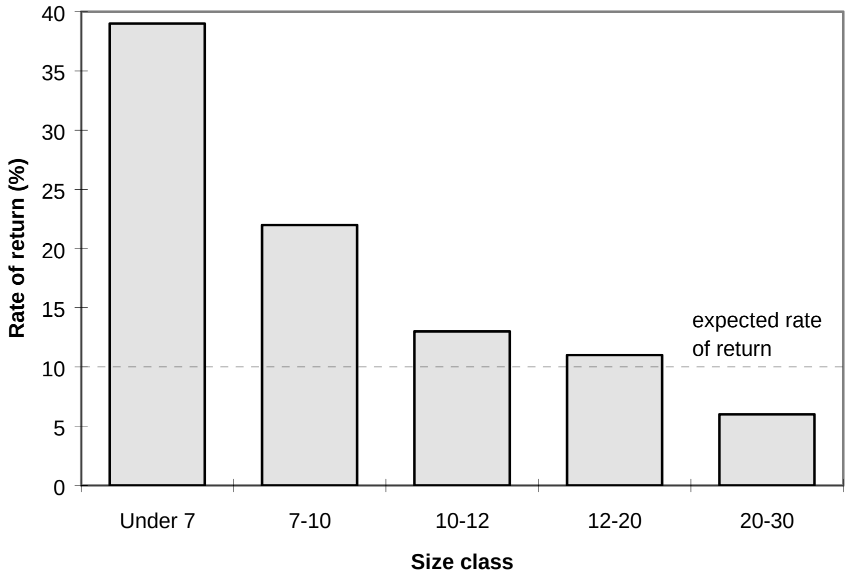
Notes: a) MAFF 1995, b) Tom Sanderson, MAFF, personal correspondence c) MAFF 1996, d) Linton Parks PLC 1995, e) relates to 1991-92 (Hillis and Whelan 1994)

Full equity profits and rates of return to capital

Full equity profits are taken as revenue less economic costs. As the costs include all returns to labour, full equity profit is a measure of the economic return to the capital in the fishery. As indicated above, another indicator of economic returns is the rate of return to capital. This is the ratio of full equity profit to capital value. As an explanatory indicator of economic performance it is offers more than if either full equity profit or capital value are considered in isolation.

The rate of return can be compared with an expected rate of return to determine whether or not the boat is covering its opportunity cost (Figure 8). The expected rate of return for was taken as 10 per cent based on the Linton Park PLC rate of return. In the case of the under 7 metre boats it was noticeable that the rate of return was 39 per cent, relatively high compared to the other size classes. Generally with surveys of this nature it would be normal to consider the possibility that the high rate of return is because of sample bias in this group. For example, those agreeing to be interviewed could have been the better fishers. Whilst this group had a proportionately high rate of non-response there was no evidence to indicate whether or not the interviewed operators were significantly different than the non-respondents. A more likely explanation for the high rates of return is that this group was characterised by a low mean capital value. This meant that high rates of returns could be achieved even with a relatively low full equity profit. The mean value was also influenced by one observation with an exception rate of return, the result of a very low capital value (Figure 9).

Figure 8. Estimated rates of return by size class



From Figure 8, it can be seen that boats under 10 metre in length had rates of return that, on average, exceeded the expected rate of return. In other words capital invested in this part of the fishery on average earned a greater return for society than the next best alternative. Since the returns were greater than what would be required to keep the fisher in the industry, these boats were considered to be earning, on average, positive economic profits[11]. However, as previously discussed in relation to the under 7 metre boats, this was more likely to be a function of the relatively low capital value than relative efficiency in production.

For boats within the 10 to 20 metre range, the rate of return to capital was slightly higher than the expected rate of return. However, given the possible margins of error surrounding the mean values, it can be concluded that there were no significant economic profits being earned. In contrast, the 20-30 metre boats were making economic losses on average since the estimated average rate of return was less than the expected rate of return.

The distribution of the rates of return for the different size classes are given in Figure 9. About 9 per cent of fishers interviewed were earning positive full equity profits but had rates of return less than 10 per cent. This implies that they were covering their own labour costs but were not covering the opportunity cost of capital. A further 20 per cent of boats had negative full equity profits and hence negative rates of return to capital. This implies that they were not covering the opportunity cost of either labour or capital. In total, 29 per cent of boats had rates of return less than the expected rate of return (inclusive of over 30 metre boats, not presented in Figure 9).

[11] This is also termed supernormal profits. For a further explanation of economic profits and supernormal profits, see Nicholson 1989 or Begg, Fischer and Dornbusch 1991.

Figure 9. Distribution of rates of return

Financial and economic performance by fishing activity

The financial and economic performance of the fishery was also estimated on the basis of principle gear type. This was to examine the relative performance of particular fishing activities. From Table 9, eight separate fishing activities were identified from the sample. Of these, only five activities were represented by more than three boats. To preserve confidentiality and maintain statistical significance, only details on the activities with three or more boats are presented in the analysis.

Financial performance indicators

A breakdown of the key costs and revenue for the different fishing activities are presented in Table 22 and Figure 10. The activities are presented in order of increasing revenue.

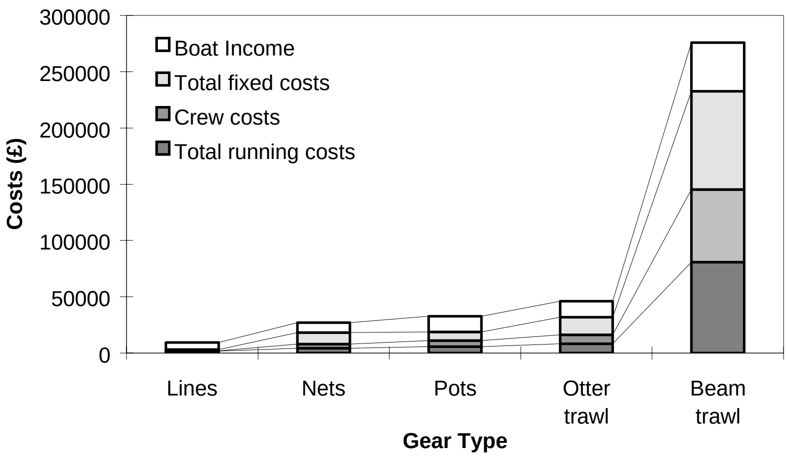
Revenue

Average revenue varied considerably by fishing activity. Line boats had an average revenue of less than £10,000 whilst beam trawlers had an average revenue of around £276,000. The line boats tended to be the smallest boats on average while the beam trawlers were the largest boats (Table 9). Net and potting boats were similar in size and engine power (Table 9). As previously discussed, many potting boats used nets as a secondary gear, whilst many netting boats also used pots. This similarity in activities resulted in similar revenues being earned.

Table 22. Financial performance indicators by gear type (£, average per boat, 1994-95)

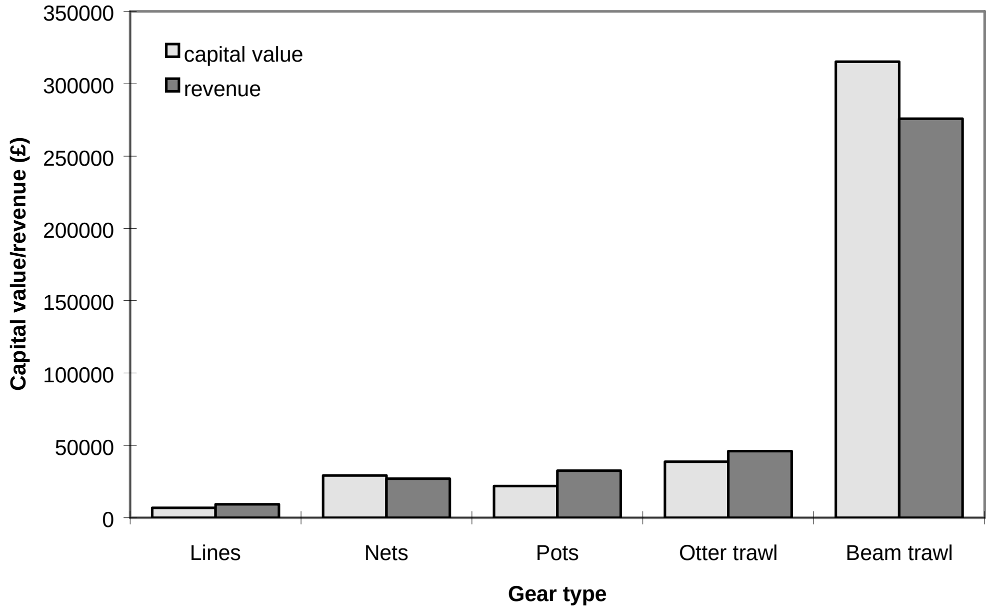
	Lines		Nets		Pots		Otter trawl		Beam trawl	
	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Revenue	9321	45	26899	28	32572	20	46027	20	275946	11
Running costs										
• Fuel and oil	844	45	1395	33	1303	28	4546	20	48327	19
• Ice	79	79	286	58	6	111	505	41	2657	14
• Food	0	0	499	64	213	113	696	43	8378	10
• Bait	293	120	28	91	3941	25	0	0	0	0
• Levies	491	49	1921	28	134	54	2583	30	21365	12
Total running costs	1706	49	4129	31	5597	27	8330	21	80727	15
Crew costs	253	126	3933	44	5483	25	7796	28	64462	15
Fixed costs										
• Repairs and Maintenance	580	41	5297	25	4118	28	9894	26	49631	25
• Harbour dues	117	70	600	36	359	27	767	33	5078	26
• Insurance	66	107	1131	53	816	15	1604	20	14792	17
• Administration	25	115	454	42	670	21	863	21	3708	24
• Survey costs	6	0	198	74	0	0	12	120	4428	47
• Equipment hire	0	0	336	77	92	50	479	29	2214	32
• Other rental	92	156	0	0	59	63	28	135	0	0
• Interest	0	0	1872	88	390	46	1261	60	5985	65
• Other costs	217	115	389	69	1150	25	880	26	1595	46
Total fixed costs	1104	53	10278	33	7655	23	15788	21	87431	18
Boat Income	6258	57	8559	53	13836	23	14112	24	43326	35

Figure 10. Financial performance indicators by gear type



Average revenues were approximately equal to the average capital value of the boats (Figure 11). Capital investment can be considered an indicator of effort, so it is not surprising that revenue is highly correlated to the capital value. However, it was only coincidence that the value of the catch was roughly equivalent to the value of the boat. Revenue is determined by both catch and market prices. Under different prices or levels of stock abundance the relationship may not have been as strong.

Figure 11. Boat revenue and capital value



Running Costs
Fuel costs were generally the major running cost item for most fishing activities. For the two trawling activities, fuel and oil costs accounted for about 60 per cent of total running costs. Ice costs and food costs were also highest for the trawlers. As previously stated, trawlers tended to have longer trips so more ice was needed to preserve the catch. Similarly, longer trips require the provision of food for the crew.

Bait costs were the highest running cost item for the potting boats, accounting for about 70 per cent of the total running costs. Bait costs for the trawling activities were, as expected, zero. Fishers in the netting category also had bait costs as many net boats also tended to be pot or line fishers.

Levies were proportionally higher for the activities involving fish rather than shellfish. For these boats, levies were fairly consistent across the board, between 5 and 7 per cent of revenue. Conversely, potting boats had an average levy rate of less than 0.2 per cent of revenue. As previously stated, this was due to the fact that potting boats sold their catch through agents who generally did not charge a levy, whereas most fish were sold through auction markets. Many of the trawler operators were also members of POs, thereby incurring additional levies over and above those charged by the markets. In contrast, most potting boats interviewed were not members of a PO so did not incur additional levies.

Crew costs
Crew costs were greatest for the beam trawlers. This reflected a greater number of crew on these boats. On a per day basis (derived from Table 13), crew aboard the beam trawlers were also paid substantially more than crew on the other boats types (Table 23). This most likely reflected the length of the day fished as well as the amount of work required in sorting larger average catches. The crew aboard line boats received the lowest average payment per day. This could be an artefact of the use of

mean values, as most line boats did not employ crew members (as indicated in Table 23).

Table 23. Mean payment per crew member by fishing activity

Gear type	Crew share (£)	Average number of crew	Mean payment per crew member (£)	Mean payment per day fished (£)
Lines	253	0.2	1265	7
Nets	3933	0.8	4916	33
Pots	5483	0.8	6854	34
Otter trawl	7796	1.2	6497	44
Beam trawl	64462	3.3	19534	76

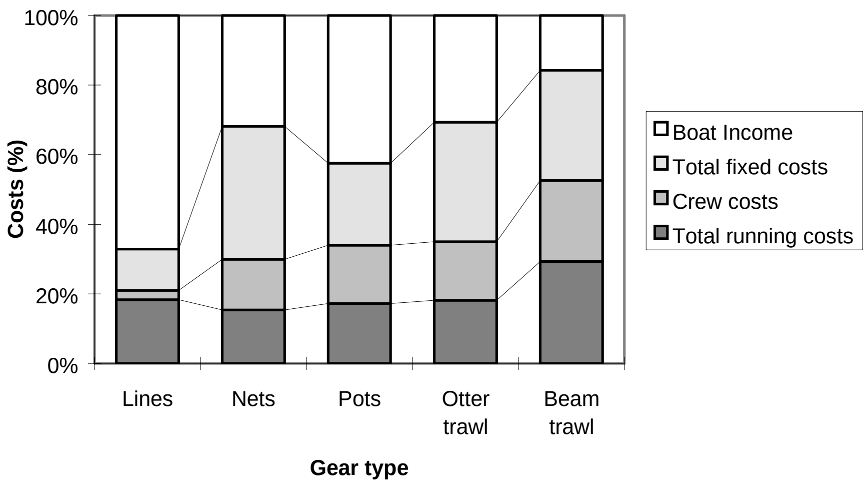
Fixed Costs

Most of the indicators follow a predictable pattern given that larger boats tended to be trawlers and small boats tended to be line fishers and potting boats. The beam and otter trawlers tended to have higher harbour dues and insurance costs, higher administration costs and tended to hire more equipment than the other boats. This is largely a result of the relative size of boats, as previously discussed.

Boat income

Boat incomes followed a similar trend to fishing revenue, with the line boats having the lowest boat income whilst the beam trawlers had the highest boat income (Table 22). However, boat income as a proportion of revenue was greatest for the line boats (Figure 12).

Figure 12. Costs and boat income as a proportion of revenue



On average, boat incomes were positive for all gear types used. However, as was found in the size class analysis, not all boats earned positive boat incomes (Figure 13). While beam trawlers had the highest boat income on average, it also contained boats with the greatest absolute loss.

Figure 13. Distribution of boat income by main gear type

Economic performance indicators

Economic performance indicators by gear type are summarised in Table 24 for the five main gear type activities. Again, economic revenue is assumed to equate to financial revenue. Similarly economic running costs equate to financial running costs. Also, as in the previous section on economic performance by size class, modifications have been made to labour costs and fixed economic costs.

Total economic costs followed the same trend as revenue and capital value. Of the gear types presented, line boats had the lowest capital value and the lowest absolute total costs. Beam trawl had the highest capital value and highest absolute total costs.

Table 24. Economic performance indicators by gear type (£, average per boat, 1994-95)

	Lines		Nets		Pots		Otter trawl		Beam trawl	
	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Revenue[a]	9321	45	26899	28	32572	20	46027	20	275946	11
Total running costs[a]	1706	49	4129	31	5597	27	8330	21	80727	15
Labour costs										
• Crew[a]	253	126	3933	44	5483	25	7796	28	64462	15
• Skipper	2777	44	7051	25	8639	17	10299	18	29702	8
Total labour costs	3030	40	10984	30	14122	18	18095	22	94164	12
Fixed economic costs										
Total fixed costs[a]	1104	53	10278	33	7655	23	15788	21	87431	18
• Less interest and rental costs[a]	92	156	2209	86	542	43	1767	42	8199	53
• Plus depreciation	150	59	645	45	482	31	850	21	6933	17
Total fixed economic costs	1162	48	8714	26	7595	23	14871	22	86165	18
Full equity profit	3423	74	3071	85	5257	35	4731	34	14890	99
Capital value	6817	59	29322	45	21915	31	38650	21	315137	17
Rate of return (%)[b]	50		10		24		12		5	

notes: a) From Table 23. b) Estimated by dividing full equity profit by capital value. No relative standard error was estimated.

Economic labour costs

Labour costs accounted for between 30 and 40 per cent of gross revenue. For the line boats, most of the labour costs were attributed to the imputed value of the skipper labour, as actual crew payments were relatively small.

Fixed economic costs

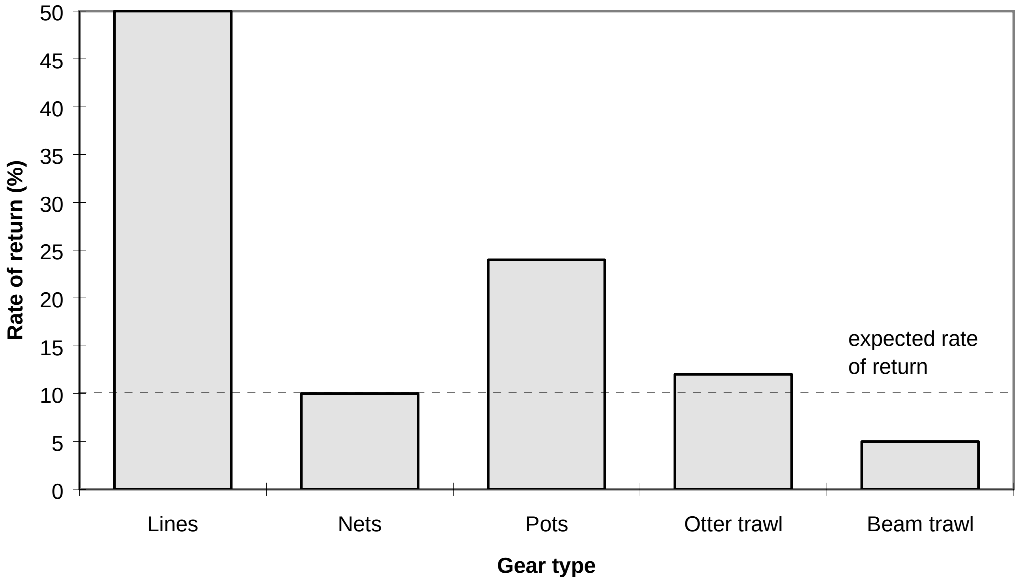
Fixed economic costs were estimated as in the previous section on economic performance by boat size class. These followed the same trend as other indicators previously mentioned. Beam trawlers had the highest fixed economic costs and line boats had the lowest fixed economic costs.

Full equity profits and rate of return

Economic performance by gear type for the fleet is summarised in Figure 14. While line boats had a relatively low full equity profit in absolute values, the level of full equity profit expressed as a percentage of boat capital (the rate of return) was exceptionally high. Line boats had the greatest returns to capital at 50 per cent (Figure 14). However, this was largely driven by one boat that had a relatively high weighting and also a very high rate of return (Figure 15). Most boats in this group had rates of return less than 50 per cent. Whilst still relatively high, these returns in part reflect the relatively low capital value of the boats[12].

[12] The arguments that apply here are those presented for the under 7 metre size class who exhibited a rate of return of a similar magnitude.

Figure 14. Rates of return by gear type



The rate of return for potting boats at 25 per cent was also high. This was largely due to a low capital value of the boat and that they target high value species close in shore using static gear. Hence revenue was high relative to costs. The rates of return of otter trawlers and net boats were equivalent to what could have been earned if the capital had been invested elsewhere. Beam trawlers were the only reported group making an economic loss given an expected rate of return of 10 per cent (Figure 14). While beam trawlers had the highest full equity profit in absolute terms, they also had the highest capital values resulting in a low rate of return to capital.

The economic performance of the fleet by gear type paralleled that by size class. Larger boats tended to use mobile gear while smaller boats tended to use static gear. It is unlikely that current beam trawlers would benefit greatly by replacing their trawl gear with lines since much of the benefits associated with lines may be attributable to the size of the boats using lines rather than the actual gear used.

For all gear types a number of boats were making negative rates of return to full equity capital (Figure 15). This reduced the average rate of return for each gear type. In contrast, the modal[13] rates of return to full equity capital for boats using gear other than beam trawl was between 25 and 30 per cent (Figure 15). The modal rate of return for beam trawlers was around 10 per cent. Hence, most boats in the fishery were earning normal or above normal returns.

[13] The mode is the value with the highest frequency.

Figure 15. Distribution of rates of return by gear type

Overall value of the fishery

The survey results can be extrapolated to provide an indication of the value of the fishery to the economy of southern England. An assumption behind this extrapolation is that the boats in the sample are representative of their respective groups in terms of fishing activity. While the sample was considered representative in terms of physical characteristics, there was no information on which to base the representativeness of the fishing activities undertaken by these boats. Consequently, the total values for the fishery should be viewed with caution, and as indicative only.

The economic benefits of the fishing activity are not the same as the total economic benefits derived from the fish resource as a whole. In the latter case, economic benefits would include alternative or complementary uses of the resource and also the benefits derived by society from the existence of the resource (that is, its non-use value). More than likely, economic benefits from the resources as a whole would be greater than the financial revenue generated by harvesting the resource. Intuitively this means that society values its fish resource beyond the financial gains extracted from it. With respect to the economic data presented below the perspective taken is society's value as measured by the benefits and costs associated with harvesting the resource.

The total values for the fishery were estimated by multiplying the overall weighted mean by the number of boats in the fishery. Since the relative standard error was expressed as a percentage, the relative standard error associated with the mean value was also applicable to the fishery total. Multiplying the weighted average by number of boats produces the same values as by grossing up the results of each size class.

Total revenue from fishing in 1994-95 based on the survey results was estimated to be about £94.4 million, with a relative standard error of 17 per cent (Table 25). Thus, there is a 95 per cent probability that the true total fishery revenue was within the range £94.4 million ± 34 per cent (that is, two times the relative standard error), or between £62.3 million and £126.5 million. From this it can be seen that there is a considerable degree of uncertainty surrounding the extrapolated figures.

The value of catches recorded in logbooks in 1994 was £66 million[14], which was extrapolated to incorporate boats that did not submit logbook returns to £103 million (see Appendix B and Table 2). While this latter estimate was also subject to considerable uncertainty, it is of similar order of magnitude to that estimated by the survey results.

Table 25. Estimated total fishery values of key variables, 1994-95

Measure	Overall mean (£/boat)	RSE	Total fishery value (£m)	RSE
Revenue	43 582	17	94.4	17
Crew and skipper	17 262	15	37.4	15
Full equity profits	4 790	31	10.4	31
Interest	1 054	44	2.3	44
Total value added	22 052	15	47.8	15
Capital	40 136	23	86.9	23
Direct employment	2.24	7	4 858	7

Total returns to labour in the fishery (crew and imputed skipper costs) were estimated to be about £37.4 million in 1994-95, while total returns to capital (full equity profits) were estimated at about £10.4 million. Of this, about £2.3 million was paid to financial institutions as interest.

Total value added (the sum of the returns to labour and capital) was estimated at about £47.8 million. This was the total contribution the fishery was estimated to have made to the wider economy in 1994-95. In the short term, fishers are not likely to be able to find alternative employment outside the fishery. In this case, the total value added represents the value of the fishery to the economy (excluding non-market values that have not been estimated, as discussed in the previous sections)[15].

Total capital in the fishery was estimated to have been £86.9 million. This excludes the capital value of licences[16]. If we assume a normal rate of return of 10 per cent (as previously assumed), then the expected return to capital would have been about £8.7 million. Economic profits (taken as the difference between the total full equity profits and the expected normal profits) were estimated to have been only about £1.7 million. While in total there may have been economic profits being earned in the fishery, this does not imply that all operators were making economic profits. As seen in the previous sections, some size classes/fishing activities were making below normal

[14] Derived from MAFF logbook data.

[15] In the long term, however, fishers are able to find alternative employment, so the return to capital is the long run value of the fishery to the economy.

[16] Information on licence values was solicited from fishers. However, most fishers could not provide a confident estimate of their licence value (with many surprised that the licence even had a value).

profits (economic losses), while about 11 per cent of boats were making financial losses in the fishery.

Total direct employment in the fishery (crew plus skipper) was estimated to be about 4,800. This excluded indirect employment, such as employment in sectors of the economy servicing the fishing industry (for example, dockyards, fish merchants, chandlery etc.).

At the regional level (Table 26), the highest estimated full equity profits and total value added occurred in the Poole region. This region was characterised by a large number of predominantly small boats. Given that the information for the smallest size class of boats was likely to biased towards the more active boats, this could represent an overestimate of the total full equity profit in this region. The highest estimated total revenue was found in the Brixham region. As this region was dominated by larger boats, which were generally characterised by high costs as seen in the previous sections, total full equity profit in this region was low relative to total revenue.

Table 26. Estimated total values by administrative region, 1994-95

	Newlyn		Plymouth		Brixham		Poole		Hastings	
	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE	Mean	RSE
Revenue (£m)	21.2	38	15.1	40	27.6	26	22.1	30	9.7	18
Crew and skipper (£m)	7.6	29	6.4	36	11.1	23	8.7	27	4.2	22
Full equity profits (£m)	2.8	57	1.5	68	1.3	115	4.4	37	0.4	160
Total value added (£m)	10.4	33	7.9	40	12.3	24	13.1	28	4.7	18
Capital (£m)	22.4	38	12.6	79	29.4	31	15.3	45	8.2	34
Direct employment	994	17	524	17	714	12	2079	16	542	12

Again assuming a 10 per cent return on capital as the expected normal return, it can be seen that above economic profits in most regions were about zero or negative (Table 27). Poole appeared to have the highest level of economic profit. However, this again may be an artefact of the higher number of smaller boats which possible had biased information. As a result, the level of economic profits in Poole may have been an overestimate.

Table 27. Estimated and normal profits by region (£m, 1994-95)

	Full equity profits	Expected normal profits[a]	Economic profits
Newlyn	2.8	2.2	0.6
Plymouth	1.5	1.3	0.2
Brixham	1.3	2.9	-1.6
Poole	4.4	1.5	2.9
Hastings	0.4	0.8	-0.4

a. Based on a 10 per cent normal rate of return to investment

Discussion

With any survey, there is some uncertainty about the reliability of the results. In this case, the survey was designed in such as way as to try and capture a representative sample. This was through stratifying the population on the basis of region, boat size and engine power. The sample selected from this stratification was thought to be representative of the fleet as a whole.

While there were problems of non-response, the observations were weighted to reduce the effect of this on the sample means. A comparison of the physical attributes of the sample and those of the fleet as a whole suggest that, at least in terms of physical characteristics, the sample was fairly representative of the fleet. It can only be assumed that this extended to the financial and economic performance.

In addition, the relative standard errors (RSEs) of the key performance indicators were generally low compared with those obtained in other fisheries financial and economic surveys[17], although there were some cost components that had high relative standard errors. However, the high relative standard errors in most cases were associated with low average values. For example, interest costs for the under 7 metre size class had an average value of £10 and a RSE of 146 per cent (Table 15). In such cases, the confidence interval around the mean value was still fairly small in absolute terms. High RSEs are more problematic when associated with high mean values as the confidence intervals are then high in absolute terms. In most cases, the variables with high mean values had relatively low RSEs (Tables 15, 18, 22 and 24).

While the RSEs indicate that the results are reliable for 1994-95, they cannot necessarily be extrapolated to any other year with any degree of confidence. Revenue is a function of both price and catch. These fluctuate from year to year, particularly as stocks vary with environmental fluctuations. Consequently the key indicators are also likely to fluctuate from year to year, with some years being better than others. Nevertheless, the results describe the state of the fishery in 1994-95. As such, they are a benchmark against which future surveys can be compared, and can be used as a basis for management discussions.

The key financial performance indicators examined included revenue, fixed and running costs, labour costs and boat income. The key economic performance indicators examined included economic labour costs (skipper share plus crew costs) full equity profit and rates of return. The main difference between the financial and economic indicators was the treatment of costs. The financial indicators considered only cash costs whereas the economic indicators took account of non-cash costs where this included an imputed return for the skipper in all size classes. The effects of this change in definition of costs on the profit measure are illustrated in Figure 16.

[17] See for example ABARE 1994 and earlier issues. Many survey reports do not provide relative standard errors, so an indication of the reliability of the estimates cannot be made (see for example Davidse et al 1993, Hatcher ,Holland and Cunningham 1995, MAFF 1996).

Figure 16. Relative performance indicators

Under 7 metre boats 20-30 metre boats

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Both financial and economic profits were positive on average, however a number of boats in each size class were making losses in both a financial and economic sense (See Figures 6 and 9).

A feature of the boats surveyed was the high cost to revenue ratio's across all fishing activities and size classes. Economic costs ranged from 63 to 95 per cent of revenue, depending on the fishing activity and size class (Tables 28 and 29). For most of the boats groups, the ratio was above 85 per cent. Similarly, financial cost to revenue rations were generally high, particularly for the larger boats

Table 28. Cost to revenue ratios by size class

Size class (metres)	Economic Costs as a Proportion of Revenue (%)	Financial Costs as a Proportion of Revenue (%)
Under 7	76	46
7-10	85	57
10-12	88	69
12-20	89	72
20-30	92	85

Table 29. Cost to revenue ratios by gear type

Gear type	Economic Costs as a Proportion of Revenue (%)	Financial Costs as a Proportion of Revenue (%)
Lines	63	33
Nets	89	68
Pots	84	57
Otter trawl	90	69
Beam trawl	95	84

Cost to revenue ratios increased as capital value increased. This is the case for both size class and gear type. Assuming that costs are a reasonable proxy for the total effort applied by the fisher and that revenue is a reasonable proxy of output, then increasing cost to revenue ratios with increasing capital value suggests that diminishing returns to scale were exhibited. In other words, any increase in total effort (defined in terms of total inputs in the proportions observed in the fishery) would have resulted in a smaller increase in output.

Because the cost to revenue ratio was relatively high, full equity profit in the fishery would be sensitive to small changes in either costs or revenue. For example, a one per cent decrease in beam trawler revenue arising from an exogenous effect (for example, either a price change or stock change), would result in a nine per cent reduction in full equity profit. In contrast, a one per cent reduction in revenue resulting from an endogenous changes (for example, a one per cent reduction in effort) would reduce the full equity profit by 4 per cent.

The sensitivity of the rate of return to exogenous and endogenous changes is largely dependent on the level of capital. For beam trawlers, the high capital value of the boat resulted in the rate of return being relatively unaffected by the one per cent change in revenue (either exogenous or endogenous change). In contrast, a 1 per cent fall in the revenue of potting boats would have reduced the rate of return by about 20 per cent (that is, from 24 per cent to around 20 per cent).

Economic profits from harvesting the fisheries resources of the English Channel can be subdivided into a number of components. Of key interest to fisheries management is resource rent. Resource rents are the returns to the owner of the resource for the use of the resource[18]. Another key component of economic profits are intra-marginal profits. These are returns to the operator for running a more efficient boat than others in the fishery.

By definition, resource rent can only exist when all boats are making positive economic profits (Anderson 1989). While some boats in the fishery were earning economic profits, the marginal boats in the fishery were making negative economic profits. In fact, almost one third of the fleet were making less than the expected rate of return on investment. Consequently, resource rents were not being generated in the fishery in 1994-95. The fact that zero resource rent is being earned suggests that the fishery was overcapitalised from an economic perspective.

This was reinforced by the aggregate analysis. Overall the fishery was making about the expected level of full equity profit given the level of capital investment. That is, it was not earning any significant economic profits. Total economic profits in the fishery were estimated to be less than 2 per cent of the total fishery revenue.

Effective management programmes have the potential to generate substantial economic rents in fisheries. From other studies, a rough indication of the potential resource rent in fisheries on average is 25 per cent of the value of landings (Campbell and Haynes 1990). This would imply that potential resource rents in the English Channel fisheries may be in the order of magnitude of around £25 million a year. However, for this level of resource rent to be achieved, it is likely that the level of capital in the fishery would need to be substantially reduced. Given that there are costs in reducing the number of boats in the fishery, it may not be worth reducing the fleet to the extent required to achieve the maximum potential resource rent.

[18] For further details on the generation of resource rents, see Anderson 1986 or Hannesson 1993.

Conclusions

Improving the economic performance of the fleet is but one of many objectives of fisheries management. However, fisheries managers can only management their fisheries through applying controls on the activity of the fishers. Fishing behaviour is largely driven by economic incentives. While considerable attention has been paid to the assessment of the biological status of the English Channel fishery, little attention has been paid to the economic status of the fishery.

The analysis presented in this report is the first of its kind on the UK fleet of the English Channel. The assessment of economic performance is a key element in furthering the understanding of the economic incentives that exist in the fishery. As such it creates a benchmark against which future studies can be compared. It also addresses to an extent the imbalance between biological and economic research in the fishery.

On average, boats in the fishery were covering their cash costs, resulting in positive boat incomes. However, 11 per cent of the boats interviewed did not cover their cash costs in 1994-95. When all costs are considered, such as the non-cash costs associated with the owner-operators own labour and the opportunity cost of capital, almost one third of the fleet were found to be making economic losses. This means that, from society's perspective, greater returns could have been achieved had the capital value of the boats would been invested in the next best alternative activity. This is not to say that the owners of these boats were not all earning a financial return on their investment, just that higher economic returns could have been earned elsewhere.

The overall financial and economic performance of the fleet is difficult to determine given only one year's data. Performance has generally been considered by reference to average values. However, considerable variation in performance was observed within the boat categories. This variation is not apparent when examining mean values only. Fisheries managers should be as concerned with the performance of the marginal boats as for the average performance of the size class or fishing activity, since the generation of resource rents relies on the marginal boats earning economic profits. This also provides information on the strength of performance of the fishery as a whole and the likely incentives for new entrants to the fishery.

From a management perspective catch and effort controls will dramatically alter the financial and economic viability of the fishery in the short to medium term. In the longer term, however, management controls could lead to higher average revenues which would redress the balance. Managers will need to take into consideration the potentially severe short term effects when developing longer terms management strategies.

Appendix A. Estimation of total value of landings

The total value of landed catch was estimated from the value of the recorded catch in 1994. Not all boats are required to record catch. Generally, only catches of quota species are recorded. Boats less than 17 metres overall length that fish for less than 24 hours do not need to lodge catch returns with MAFF, unless they are catching (and landing) quota species. Boats 10 metres and under are not required to complete logbook returns at all (although a small number do so).

The number of boats that completed logbook returns for the English Channel is given in Table 31. These landings were valued at the prevailing market prices to provide an estimate of the recorded value of landings (Table 32). This was scaled up by the number of boats registered in ports along the English Channel in 1995 (Table 1) to provide an estimate of the total value of landings by UK boats for the Channel as a whole (Table 2). For one size class category (20-30 metre boats), the number of registered boats in 1995 was less than the number of boats providing logbook returns in 1994. For this category, the estimated value of landings was scaled down.

Table 31. Number of boats who recorded catch in the English Channel in logbooks, 1994

	Size class (metres)						
	Under 7	7-10	10-12	12-20	20-30	30+	Total
Newlyn	13	44	34	51	37	2	181
Brixham	1	15	18	24	38	1	97
Plymouth	14	42	39	10	10	0	115
Poole	39	44	21	1	2	2	109
Hastings	4	42	31	13	6	0	96
Total	71	187	143	99	93	5	598

source: MAFF

Table 32. Logbook value of landings, 1994

	Size class (metres)						
	Under 7	7-10	10-12	12-20	20-30	30+	Total
Newlyn	133904	2011983	2675946	3192239	5127867	472857	13614796
Brixham	184	1339499	1484772	5399577	18508505	12356	26744893
Plymouth	16062	2004128	4150706	2118836	3599221	0	11888953
Poole	176966	1526901	978565	7264	928612	531749	4150057
Hastings	2933	1732941	3048057	1415539	2480153	0	8679623
Total	330049	8615452	12338046	12133455	30644358	1016962	65078322

source: MAFF

Appendix B. Statistical techniques employed

Sampling strategies

In most cases, it is not practical to undertake a complete census (that is, collect information from the entire population), so a sample must be selected. A number of methods exist that can be used to select a sample.

Random samples are particularly useful when little is known about the target population. As the name suggests, a random sample is derived by randomly selecting individuals from within the population. For example, names can be pulled from a hat (for small populations), or can be randomly selected by a computer. With a random sample, each individual has the same probability of being selected in the sample.

Stratified random samples take advantage of additional information of the fishery. For example, if boat length information was available, the survey could be stratified on the basis of this variable. This can be achieved by ordering the population from, say, smallest to largest boat. A sample could be selected by taking, say, every 10th boat. The sample is still random in the sense that it is selected on a purely objective basis.

Boats can be stratified by several variables to increase the chance that the sample is balanced. For example, the boats could be grouped into several size classes. These size classes could be further divided into, say, engine size classes. A number of boats could be randomly selected form each group as representative of the group.

With any sample there may be sample error. Sampling error occurs when the sample selected is not representative of the target population. This results in sample bias, which results in the sample means being either higher or lower than the true population mean. Detecting sample error is often impossible. As the true values are unknown, there is no benchmark available against which the sample estimates can be tested.

As there is a possibility that not all sub-groups within a population will be represented in a pure random sample, they are more subject to sampling errors than stratified random samples. With a small sample there is a greater chance that a pure random sample will be biased compared with a stratified sample. That is, the sample may incorporate more observations from one segment of the population than another. As each observation in a pure random sample is given equal weight, a biased sample will produce biased estimates of the parameter of interest. Pure random samples have to be considerably larger than stratified random samples in order to ensure that bias is not introduced into the estimates.

The potential for sample bias is reduced through using a stratified random sample. Since the population has been stratified, a balanced sample can be chosen that is more likely to be representative of the population than a purely random sample. Consequently, smaller samples can still provide reliable information if they are derived from a stratified population.

Sample statistics

The purpose of collecting information from a sample is in order to make some inferences about the population. The usual measure of interest is the mean characteristics of the population, or subgroups within the population. This is given by

$$\mu \approx \bar{x} = \frac{\sum_i x_i}{n}$$

where μ is the population mean, $\bar{x}$ is the sample mean, n is the number of observations in the sample and x_i is the value of observation *i*.

A measure of confidence is also required in the population mean. The level of confidence is related to the amount of variation around the mean, so is related to the standard deviation.

The standard error is an indicator of the level of confidence in the estimate. The standard error is given by

$$se = \frac{s}{\sqrt{n}}$$

where s is the standard deviation of the sample, given by

$$s = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{n-1}}.$$

Standard errors provide information about the confidence interval around the mean. Assuming that the distribution is normally distributed around the mean), there is a 95 per cent probability that the true population mean is within the range

$$\bar{x} - t_{0.025,n-2}\frac{s}{\sqrt{n}} \le \mu \le \bar{x} + t_{0.025,n-2}\frac{s}{\sqrt{n}}$$

where $t_{0.025,n-2}$ is the critical value of the t-statistic at the 5 per cent level of significance and n-2 degrees of freedom. This value can be read off any t-statistic table. For the number of observations in the sample, the critical values of the t-statistic ranged from roughly 2.1 to 2.6 depending on the number of observations in each size class. For the sample as a whole, the critical value is approximately 2.

As the standard error is dependent upon the number of observations in the sample, the larger the sample, the smaller the standard error and the tighter the confidence interval around the mean. Consequently, the larger the sample, the more confidence that can be placed on the sample estimate (McClave and Dietrich 1994).

In this report, standard errors are expressed as relative standard errors. These are the standard error expressed as a percentage of the mean, given by

$$rse = \frac{se}{\bar{x}}100$$

Sample weighting

With a purely random sample, there is an equal probability that any particular individual unit will be selected in the sample. As a result, it would be expected that the distribution of units in the sample would be approximately equal to the distribution of units in the population. As a result, every observation is given an implicit weight of 1.

With stratified samples, the number of units each observation is representing is known. The sample remains unbiased (balanced) as long as the sample size in each strata is proportional to the proportion of the population in each strata. For example, if a particular strata contains 10 per cent of the population, then the sample from that strata should be 10 per cent of the total sample.

The final sample may not necessarily be distributed the same as the population due to problems such as non-response. For example, the rejection rate may be higher in one strata than another, and suitable replacements may not be able to be surveyed. This was the case in this survey, as indicated by the divergence between the target and final sample structure. The original target sample was balanced as the sample within each strata was selected proportionally across the strata based on engine power. Where suitable replacements for non-respondents could not be found, the sample became unbalanced, with more boats at one end of the strata than the other.

To compensate for this, the observations can be weighted on the basis of the number of individuals they represent. The weighted sample mean can be given by:

$$\mu \approx \bar{x} = \frac{\sum_i w_i x_i}{\sum_i w_i}$$

where w_i is the weight of observation i. The simplest weight to use is the number of individuals that each sample is representing. For example, an observation may be representing 10 individuals, so that it can be given a weight of 10. In this survey, some boats were required to represent more boats than others within the same strata due to difficulties in obtaining interviews with owners of target boats.

The weights were standardised so that the sum of weights was equal to the sample size. The weights were therefore calculated by

$$w_i = r\frac{n}{N}$$

where n is the sample size, N is the total number in the population and r is the number of boats each sample point is representing. This results in some boats having weights of less than 1 and other boats having weights greater than one. This does not affect the weighted mean estimate.

Figure 17. Distribution of sample weights

The resultant distribution of the weights is shown in Figure 17. As the sample was selected on the basis of both value of catch and boats numbers, while the weights are based solely on boat numbers, the average weight of the larger boats was generally less than one, while the weight of small boats was generally above one. Poor responses from the smallest boat groups resulted in the sample points in these groups have relatively high weights.

In SPSS, the statistical package used in analysing the data, the standard errors were calculated on the basis of the sum of weights rather than the actual number of sample points. Standard errors were estimated manually by estimating the standard deviations using SPSS and dividing these by the square root of the number of sample points, as given in the above equations.

Estimation of optimal sample sizes

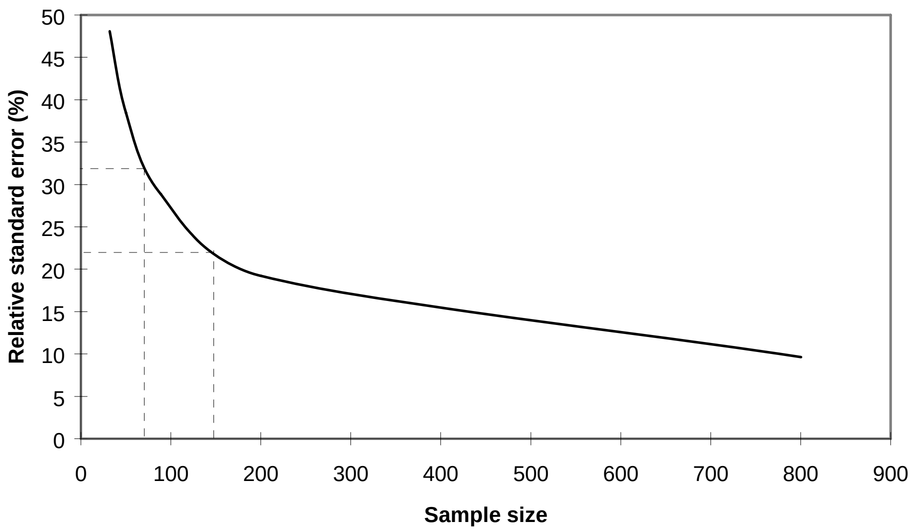
From the previous section, the confidence interval of the mean is a function of the standard deviation of the sample and the sample size. Increasing sample size will reduce the bounds of the confidence interval, but also increase cost. In most cases, policy makers are willing to accept some uncertainty in the estimates. Provided that they can specify the degree of certainty, (and provided that some preliminary survey has already been undertaken to provide an indication of the variance in the population), the optimal sample size can be calculated.

The sample size required, n, to produce a standard error, se, given a known standard deviation, s, is determined by

$$n = \left(\frac{2s}{2se} \right)^2$$

From the Channel fishery survey, the sample size would have needed to be increased substantially in order to improve on the level of confidence in the survey results. For example, the total fishery full equity profit had an estimated value of £10.4 million with a RSE of 31 per cent. Doubling the sample size would have reduced the RSE to only 22 per cent (Figure 18), assuming the standard deviation was of similar order of magnitude. As the target population was stratified to include a wide range of boats in the sample, it is unlikely that the standard deviation would have changed significantly with a larger sample size.

Figure 18. Relationship between RSEs and sample size



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